



Graduate Theses, Dissertations, and Problem Reports

2018

Fear of Pain across the Adult Lifespan

Casey D Wright

Follow this and additional works at: <https://researchrepository.wvu.edu/etd>

Recommended Citation

Wright, Casey D, "Fear of Pain across the Adult Lifespan" (2018). *Graduate Theses, Dissertations, and Problem Reports*. 7278.

<https://researchrepository.wvu.edu/etd/7278>

This Thesis is protected by copyright and/or related rights. It has been brought to you by the The Research Repository @ WVU with permission from the rights-holder(s). You are free to use this Thesis in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you must obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/ or on the work itself. This Thesis has been accepted for inclusion in WVU Graduate Theses, Dissertations, and Problem Reports collection by an authorized administrator of The Research Repository @ WVU. For more information, please contact researchrepository@mail.wvu.edu.

Fear of Pain across the Adult Lifespan

Casey D. Wright

Thesis submitted to the Eberly College of Arts and Sciences
at West Virginia University

in partial fulfillment of the requirements for the degree of

Master of Science in
Psychology

Daniel W. McNeil, Ph.D., Chair
Nicholas A. Turiano, Ph.D.
Richard T. Gross, Ph.D., ABPP

Department of Psychology

Morgantown, West Virginia
2018

Keywords: fear of pain, development, age
Copyright 2018 Casey D. Wright

ABSTRACT

Fear of Pain across the Adult Lifespan

Casey D. Wright

Acute and chronic pain continue to be important areas of concern in public health globally. Fear of pain, although understudied on a broader scale, is in fact a well-known predictor of and close associate to pain. Nociception and pain experiences differ depending on age, yet little empirical evidence exists on how fear of pain varies over the lifespan. The purpose of this thesis was to examine the relation of age and fear of pain across the adult lifespan. Results of a structural equation model were indicative of a positive linear association between age and fear of severe or minor pain, and a negative association with fear of medical or dental pain. Quadratic and cubic relations also were significant for fear of severe pain, fear of medical and dental pain, and the total score, but not for fear of minor pain. Latent class analyses were used to extract five classes, which were predicted by age and sex. Post-hoc analyses indicated differences based on age and sex. One of the unique classes with higher fear of minor pain on average was the youngest, and was predominantly male. Results help to understand the relation that age has with different types of pain-related fear. Fear of medical or dental pain may be influenced by exposure due to increased medical and dental experiences in aging adults. Additional research is needed to examine the relations discovered here.

Table of Contents

ABSTRACT	ii
Table of Contents	iii
ACKNOWLEDGMENTS	v
Defining Pain	1
Associations Between Fear, Anxiety, Stress, and Pain.....	5
Defining Fear of Pain.....	7
Theories of Fear of Pain.....	9
Importance of Studying Fear of Pain	10
Pain across the Lifespan.....	12
Lifespan Considerations for Fear of Pain	15
Statement of the Problem.....	17
Method	18
Participants and Procedure.....	18
Measures	20
Data Analyses	21
Results.....	24
Assumptions and Missing Data	24
Descriptive Statistics.....	26
Structural Equation Model (SEM)	26
Latent Class Analysis (LCA).....	28
Discussion.....	29
Limitations	32

Conclusions.....	34
References.....	35
Tables.....	48
Table 1.....	48
Table 2.....	49
Table 3.....	50
Table 4.....	52
Table 5.....	53
Table 6.....	54
Table 7.....	55
Figures.....	56
<i>Figure 1</i>	56
<i>Figure 2</i>	57
<i>Figure 3</i>	58
<i>Figure 4</i>	59
<i>Figure 5</i>	60
<i>Figure 6</i>	61
Appendix A.....	62
Appendix B.....	63
Appendix C.....	64

ACKNOWLEDGMENTS

As another chapter of my educational career ends with the completion of this thesis, I would like to thank those who have helped me come this far. Thanks to those who provided archival datasets and thanks to the participants who contributed any of the data for this project. The longer I am in graduate school, the more I have come to appreciate my prior experiences at Utah Valley University. Once a small community trade school, UVU is quickly establishing itself as an innovative institute of higher education with unique training capabilities. In particular, I am thankful for the professors in the College of Humanities and Social Sciences who helped shape my love for interdisciplinary work, provided formative experiences in research and writing, and that prepared me well for graduate school. I am likewise grateful for my experiences in the Instructional Psychology and Technology department at Brigham Young University while completing my first master's degree. It was there that I caught the vision of research, methodology, philosophy of science, expanding my horizons, and not being afraid of questions. BYU shaped my thinking and the faculty there were exemplary in the ways they acted with extreme intelligence, integrity, and humility. The first two years of my training at West Virginia University has been a couple of the more difficult years in my life, yet they have pushed my thinking and fueled my passion for science. I have my cohort and friends in the psychology department to thank (you know who you are), as well as past and present Anxiety, Psychophysiology, and Pain Laboratory members. A special thanks to Dr. Rick Gross and Dr. Nick Turiano for serving and advising me on my committee. An extremely patient man to work with me as his student, I am immensely grateful for Dr. Dan McNeil, my advisor and mentor. His passion for giving students seemingly endless opportunities and his love of learning are contagious. I am thankful for him and his guidance on this project. Though they probably will

not remember these last two years, I want my two sons to know how they have motivated and helped me want to be my best. Thanks for cheering me on and telling me, “You got this, daddy!” I especially have my best friend and wife to thank for pushing me to be a better person each day and being patient with my many weaknesses and failed work/life balance.

Fear of Pain across the Adult Lifespan

Beyond the certainties of death and taxes (DeFoe, 1726), at least one other phenomenon is almost universally experienced in life — pain. It is one of the primary reasons people seek healthcare, yet is complicated to treat due to the diversity of individual pain experiences (National Institutes of Health, 2017). Fear and anxiety related to pain have important implications for how providers approach and deal with patients of all ages who report pain. Little is understood, however, in terms of how pain-related fear is characterized from a developmental perspective. This study was aimed to explore and characterize the association between age and pain-related fear.¹ Better understanding fear of pain and its association with age can potentially help in additional research in the areas of acute and chronic pain, healthcare delivery, and aging.

Defining Pain

The International Association for the Study of Pain (IASP) broadly defines pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage” (Merskey & Bogduk, 1994, p. 210). Because it is both a “sensory and emotional experience,” the topic of pain is transdisciplinary, with scientists in physiology, medicine, neuroscience, psychology, genetics, and others all interested in understanding its etiology and implications. A number of terms can be used to describe pain (i.e., pain perception, pain experience, pain expression) and each has a slightly different meaning. Likewise, a number of factors have long been shown to contribute to pain (e.g., personality, behavior) and have been used in the treatment of pain disorders (e.g., pharmacological treatments such as opiates, psychological/behavioral treatments such as distraction and relaxation, physiological treatments such as acupuncture; Liebeskind & Paul, 1977).

¹ Definitional issues exist when discussing fear and anxiety. For simplicity, when the term “fear” is used in this document, it also is intended to convey “anxiety” and vice versa. See pages 4-5 for more information.

Pain appraises the individual experiencing it (and others in the individual's surroundings) of important environmental and sensory stimuli that may be potentially harmful or that may indicate a dangerous physiological process that is ongoing (Lim, 1970). The long-standing IASP definition of pain also alludes to the *purpose* of pain by stating it is "associated with actual or potential tissue damage" (Merskey & Bogduk, 1994, p. 210). Interesting to note is the experience of pain can be due to *actual* (nociception) or *potential* (threat or impending) tissue damage. A variety of types of pain can be associated with tissue damage. Different "classifications" of pain mentioned in the literature include acute, recurrent acute, chronic, and cancer pain (American College of Emergency Physicians, 2009).

Acute pain "is a response to acute disease or injury and acts as a warning signal" for the one experiencing it (Grichnik & Ferrante, 1991, p. 217). Acute pain triggers a variety of physiological (e.g., reflexes in the muscular, skeleton, and digestive systems) as well as psychological reactions (e.g., anxiety, fear, stress) that can help in preparing for, escaping, or avoiding potentially harmful situations (Grichnik & Ferrante, 1991). Since most individuals experience disease, accidents, and other pain-inducing events, pain (both acute and chronic) is one of the primary reasons why individuals seek healthcare (Grichnik & Ferrante, 1991; National Institutes of Health, 2017).

Nearly a quarter of Americans have reported a pain experience lasting longer than one day (National Institutes of Health, 2017). Chronic pain historically has been defined as persisting longer than six months. More recently, however, chronic pain has been defined as being experienced anywhere between three to six months (International Association for the Study of Pain, 1986; Merskey & Bogduk, 1994; Treede et al., 2015). Several types of chronic pain have been identified including primary, cancer, postsurgical and posttraumatic, neuropathic, headache

and orofacial, visceral, and musculoskeletal pains (see Treede et al., 2015). It is not uncommon for chronic pain to be resistant to prior treatment, impacting everyday behavior of those that suffer from it (Russo & Brose, 1998).

Previous studies have indicated variability in pain across different demographic factors. For example, women tend to report higher levels of pain and men lower levels (see Fillingim, King, Ribeiro-Dasilva, Rahim-Williams, & Riley, 2009; van den Hout et al., 2001). Differences also exist across races and ethnicities (e.g., African Americans and Hispanics generally have lower pain tolerances and Caucasians have higher pain tolerances; see Edwards, Fillingim, & Keefe, 2001).

Other factors such as physiological (e.g., genetic) and psychological factors (e.g., anxiety and mood disorders) affect individuals experiencing chronic pain as well. For example, genetic studies have concurred that certain single nucleotide polymorphisms may be associated with chronic pain. Burri et al. (2016) utilized the TwinsUK database for initial findings and a population sample from Germany for replication in an epigenome-wide analysis to identify possible genetic contributors to chronic pain. Results identified a number of gene loci that could help future studies in exploring why some individuals experience chronic pain and not others.

Various areas of research related to the psychological components of pain have emerged in the literature. One such area is in catastrophic thinking related to pain and painful experiences. Catastrophic thinking in this sense has been defined as an overall negative cognitive style attributed to the anticipation of or experience of painful events (see Quartana, Campbell, & Edwards, 2009). One study examined the mediating relationship of catastrophic thinking between depression and pain (Geisser, Robinson, Keefe, & Weiner, 1994). Geisser et al. (1994) found that catastrophizing could influence the experience pain by itself and it could be mediating

the relationship between depression and pain experiences. This study implied that treatment for psychological phenomena could influence the level of pain experienced (e.g., by reducing depression or restructuring catastrophic thinking). Of note, psychological phenomena related to pain are the perception of pain (see Wiesenfeld-Hallin, 2005; Racine, Tousignant-Laflamme, Kloda, Dion, Dupuis, & Choinière, 2012a; Racine, Tousignant-Laflamme, Kloda, Dion, Dupuis, & Choinière, 2012b) and pain sensitivity (see Wiesenfeld-Hallin, 2005).

Related to the perception of pain (and how it influences pain sensitivity) is the meaning of pain. The experience of pain can be indicative of an acute, temporary condition (e.g., tension headache), a chronic disorder (e.g., low back pain), or a life-threatening event (e.g., myocardial infarction). As such, pain has various meanings, that likely change somewhat over the lifespan. Merely suggesting that pain is positive (making one stronger) or negative (aversive) can influence the amount of pain tolerated and the amount of analgesic opioids and cannabinoids released (Benedetti, Thoen, Blanchard, Vighetti, & Arduino, 2013). Likewise, cultural influences such as faith/religiousness, the nature of pain, and more have been shown to change what pain means to an individual (Koffman, Morgan, & Higginson, 2008). The idea that pain meant something differently to various individuals was described well over 60 years ago by Beecher (1956). He described the difference in what pain means to a war-embattled soldier who lost a limb but is still alive compared to a farmer or someone else who loses a limb and worries about their livelihood (Beecher, 1956). Additionally, depending on previous experiences with pain, different expectancies about pain can be associated with the actual experience of pain (McCracken, Gross, Sorg, & Edmands, 1993).

Cancer pain can sometimes be conceptualized as its own type of chronic pain (Grichnik & Ferrante, 1991) that affects many individuals. Grichnik and Ferrante (1991) cite a few reasons

why cancer patients seem to be undertreated when it comes to their pain experience including a lack of acknowledgement of patient pain from providers, fear from providers about patient addiction, and policies about the use of narcotics.

Associations Between Fear, Anxiety, Stress, and Pain

In everyday life, the terms *fear*, *anxiety*, *stress*, and *pain* can be confused or even used interchangeably. For example, when someone loses a beloved partner, one may exclaim, “my heart *hurts!*” The question is whether this experience is actual nociception, grief about loss, or elevated stress levels. Previous work has acknowledged the number of terms used or treated as synonyms in the literature (e.g., fear, anxiety, stress, pain), and described the important similarities and differences that exist between the terms (McNeil et al., 2012, McNeil & Randall, 2014, McNeil, Vargovich, Turk, & Ries, 2012; Schneiderman, Ironson, & Siegel, 2005; Selye, 1956).

Broadly speaking, the concept of anxiety is usually more associated with worry and the *avoidance* of the *fear* response (Craske, 2003). Anxiety typically is more cognitive in nature, involving worry about proximally distant threats, but are perceived as impending (Craske, 2003; McNeil, Arias, & Randall, 2017). Anxiety typically is conceptualized by experts to be more cognitive in nature, is future-oriented in regards to time, and less physiological (McNeil et al., 2017).

Fear by definition, typically is associated with an immediate threat, eliciting physiological activation in a *flight or fight* response (e.g., heart racing, sweaty palms; Craske, 2003; McNeil, Vargovich, Turk, & Ries, 2012). McNeil and Randall (2014) described fear and anxiety as a continuum from fearless to phobia-like fear, which also implies (as is the case) that anxiety and fear are different phenomena that lay within that continuum. Fear and anxiety,

however, share some similarities in response across three systems (i.e., overt behavior, psychophysiological response, and verbal report; Lang, 1968), and in eliciting stimuli, although the immediacy of them may be a distinguishing feature.

Still another term, *stress*, also is used to describe a negative, activating emotional state (Selye, 1956; Schneiderman et al., 2005). It can be conceptualized as both a stimulus (i.e., stress) and a response (Larkin, 2005). Stress is typically associated with expected, naturally occurring life events, but ones that overwhelm an individual's ability to cope. Nevertheless, stress is a term that is used interchangeably with fear and anxiety in lay language and even in the scientific literature (McNeil et al., 2012).

Understanding the aforementioned differences and similarities are important when examining fear, anxiety, and stress as they relate to pain. The differences in operationalization for fear, anxiety, stress, and pain have indeed led to a complex literature, in part, due to the commonalities that pain shares with the other three constructs. In terms of how they are conceptualized, assessed, and treated, both pain and anxiety are similar (Gross & Collins, 1981). Though the constructs often have been treated as separate, it is important to remember how much overlap there may be in the understanding of pain, anxiety, fear or similar constructs. That is, pain and the anxiety associated with pain are both similar and different, and can interact with each other (Gross & Collins, 1981). Although fear, anxiety, and other terms are different and distinguished from each other, the terminology *fear of pain* or *pain-related fear* will be used heretofore in an ominous manner to describe both fear *and* anxiety (and how they relate to pain).

Pain also has been associated with physical and psychological distress (Parmelee, 2005). As mentioned before, the IASP definition for pain, however, also includes that psychological

constructs may lead to pain (i.e., potential tissue damage; Merskey & Bogduk, 1994). This explanation of the phenomenon of pain is interesting in light of the construct of pain-related fear.

According to existing literature, there are individual differences in both pain-related fear and pain based on sex. In general, females tend to report higher levels of fear of pain and males report lower levels (McNeil & Rainwater, 1998; van den Hout, Vlaeyen, Houben, Soeters, & Peters, 2001). Emotional differences related to chronic pain based on race and ethnicity also have been found such that African Americans experienced higher levels of pain-related emotion whereas Caucasians experienced lower such emotion (Riley, Wade, Myers, Sheffield, Papas, & Price, 2002). More specifically, *fear of pain* based also has been compared among ethnic/racial groups. African Americans and Native Americans also have reported higher levels of fear of medical/dental pain and Caucasians reported lower levels (McNeil & Rainwater, 1998).

Defining Fear of Pain

Fear of pain has been operationalized as a construct distinct from, yet interacting with and affected by, pain. Lang (1968) conceptualized fear and anxiety as the verbal, physiological, and overt-behavior responses to exogenous (and it could be argued, endogenous) stimuli. Thus, fear of pain can be described as the verbal, physiological, and overt-behavior responses to potential or ensuing painful experiences (McNeil & Vowles, 2004). Additionally, theories about cognitive processes and pain-related fear have been developed. Aforementioned studies assessing pain perception (Wiesenfeld-Hallin, 2005; Racine et al., 2012a; Racine et al., 2012b) and catastrophizing (Quartana et al., 2009; Geisser et al., 1994) are examples of how cognitive processes may influence fear of pain. In dental settings (where pain is a natural occurrence), these cognitive processes such as catastrophizing have played a role in how pain is experienced (McNeil, Vargovich, Sorrell, & Vowles, 2014) and how memories of pain and fear of pain

develop (Kyle, McNeil, Weaver, & Wilson, 2016; McNeil, Helfer, Weaver, Graves, Kyle, & Davis, 2011).

When assessing for fear of pain through the lens of a three system model (Lang, 1968), verbal responses may be measured using self-report data, structured, or semi-structured interviews. Physiological responses can be examined when analyzing heart rate, muscle tension, skin conductance, and more (Carter et al., 2002; McNeil & Vowles, 2004; McNeil & Rainwater, 1989). Overt-behavior responses to fear of pain is an area not as heavily studied, yet certain measurement techniques such as facial expression recognition and analyses of body posture have emerged as viable methods to better understand such responses (Craig, Prkachin, & Grunau, 2001; Keefe, Williams, & Smith, 2001; McNeil & Vowles, 2004).

In order to encapsulate fear of pain broadly, it is important to consider the various biopsychosocial (e.g., genetic, psychological, anthropological, social) components that may give rise to pain-related fear. For instance, recent work has shown a possible genetic predisposition towards fear of pain in a broad sense (Randall et al., 2017) as well as in specific situations such as dental environments (Randall et al., 2016a/2016b). Previous work has indicated the heritability of fear of pain. For example, a genome-wide association study (GWAS) was conducted using the Fear of Pain Questionnaire-9 (FPQ-9) as a psychological phenotype. GWAS is used to find potential genes that may contribute to the predisposition of any given phenotype. In this case, a few single nucleotide polymorphisms were implicated for the fear of minor pain subscale of the FPQ-9. The SNPs discovered were closest to the genes *TMEM65*, *NEFM*, *NEFL*, *AGPAT4*, and *PARK2* (Randall et al., 2017).

Theories of Fear of Pain

From a psychological perspective, one of the most well developed theories of pain-related fear is the fear avoidance model first introduced by Lethem, Slade, Troup, and Bentley (1983). Vlaeyen and Linton (2000) reviewed and described the applications of the fear avoidance model and its applications to chronic pain patients. In their paper, Vlaeyen and Linton described both a behavioral interpretation of fear avoidance where fear of pain is driven by previous associations that are more classically trained. In contrast, they describe a more cognitively psychological perspective where individuals appraise painful experiences in a negative manner that leads them to avoid future painful situations (Vlaeyen & Linton, 2000).

From yet another psychological perspective, Hirsh, George, Bialosky, and Robinson (2008) performed an experimental study using a cold pressor task to examine the relationship of pain catastrophizing and the fear-avoidance model of pain. Catastrophizing was not found to be statistically significant in their study, and Hirsh and colleagues hypothesized that it may have been due to the presence of pain-related fear in the model. One could then surmise the importance of fear of pain when considering the experience of pain.

Although it is well established that fear and anxiety are related to pain, knowing how to assess these psychological constructs remains difficult. McCracken, Gross, Aikens, and Carnkike (1996) highlighted this well when they reviewed various instruments used to measure pain-related fear. Like the complicated nature of measuring pain itself, the results of McCracken and colleagues show that detecting fear of pain is also complicated. The analyses indicated that different fear or anxiety measures varied based on with which pain it was associated. Thus, much is to be learned about the relations between pain-related fear and pain itself.

Importance of Studying Fear of Pain

Though there are various research-related reasons why fear of pain is an important construct, there also are a number of reasons a clinician would be interested in fear of pain. For example, pain-related fear could lead to greater pain and can be a result of pain. Lethem et al. (1983) are credited with first associating fear and avoidance with enhanced pain responses. Shortly thereafter, another paper critically reviewed the literature addressing the association of chronic pain and depression (Romano & Turner, 1985). Romano and Turner found that across a variety of theoretical and methodological orientations that indicators of depression were higher in those with chronic pain. A number of studies have assessed fear-avoidance and the part it plays in the establishment of chronic pain (Asmundson, Norton, & Norton, 1999; Buer & Linton, 2002; Crombez et al., 1999; Parr et al., 2012; Vlaeyen et al., 2001; Waddell et al., 1993). Along similar lines, Zvolensky, Goodie, McNeil, Sperry, and Sorrell (2001) examined anxiety and fear of pain in chronic pain populations by looking at subscales of an anxiety sensitivity scale and how they associate with pain-related fear. Results indicated that anxiety sensitivity scores did indeed predict fear of pain which by implication, may lead to avoidant behavior and thereby increase the probability of exacerbating chronic pain symptoms. Thus, a clinician may use or be interested in the intersections of anxiety or fear of pain because it may be helpful in informing what sort of treatment one may approach. Others may avoid seeking adequate treatment for various health related issues (e.g., dental work, vaccines) due to pain-related fear. A clinician who looks at the holistic patient would be interested in ameliorating pain-related fear leading to avoidant or inadequate overall health care or utilization.

Pain-related fear has been studied in a variety of “painful” settings and applications. For example, individuals with higher levels of fear of pain had more impactful chronic headaches in

terms of their overall quality of life and impact of symptoms. (Hursey & Jacks, 1992). Although chronic pain patients without cancer had higher levels of pain, patients with cancer had similar perceptions or fears about pain (LeMay et al., 2011). It also was noted in that study that fear of pain has been understudied in populations with cancer. Additionally, individuals who experience high levels of fear towards dental experiences also show increased levels of fear of pain (Kleinknecht, Klepac, & Alexander, 1973; Wright et al., 2017). Likewise, acute pain seems to be affected by psychological beliefs about pain. George, Dannecker, and Robinson (2006) studied catastrophizing and fear of pain on acute pain experiences (via a cold pressor task). Results indicated that although fear of pain was associated with acute pain, catastrophizing, although previously thought to influence pain, in this case was not as relevant.

The consideration of pain-related fear is important in improving the overall quality of life of those dealing with a variety of diseases. For example, individuals who show early signs of periodontal disease such as periodontitis via deeper probing depths in the maxillary and mandibular anterior sections of the mouth in combination with avoidant behavior as a result of fear of pain may have a decreased quality of life (Wright et al., 2017). Targeting fear of pain for treatment could reduce dental-care avoidance and thereby reduce the total effect of periodontal disease on quality of life. In another example from a dental setting, where acute pain naturalistically occurs, McNeil, Au, Zvolensky, McKee, Klineberg, and Ho, (2001) studied pain-related fear in patients facing orofacial pain. Orofacial pain patients experienced increased levels of fear of pain compared to controls. van Wijk and Hoogstraten (2009) also studied an acute form of oral pain – dental injections – and found fear/anxiety to be relevant as well.

In a study of fear of pain and an often controversial neurological/psychological disorder, fibromyalgia, Turk, Robinson, and Burwinkle, (2004) found that women with fibromyalgia and

elevated levels of fear of pain also reported higher rates of depression relative to those that scored lower on fear of pain. Continuing to understand fear of pain and the mechanisms of how it operates and changes over time could lead to interventions that decrease the burden of a variety of psychological and biological malady, which could be relevant for quality of life research. One other study looked at disability and the ability to work and their relationship with the fear-avoidance model (Lee, Chiu, & Lam, 2007). Certain aspects of fear-avoidant behavior were predictive of future disability and thereby influencing work (Lee et al., 2007).

As mentioned above, understanding the intersections of pain-related fear, pain itself, and other psychological constructs may lead to informed interventions and improve overall quality of life. More specifically, Sperry-Clark, McNeil, and Ciano-Federoff (1999) recommend using assessments such as the Fear of Pain Questionnaire-III (FPQ-III; McNeil & Rainwater, 1998), the Pain Anxiety Symptoms Scale (PASS; McCracken, Zayfert & Gross, 1992), the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996), and a variety of pain questionnaires (Sperry-Clark et al., 1999). Each of these measures can help in conceptualizing an overall picture of pain and its influencing factors. Suffice it to say that continuing to understand the psychological determinants and associations to pain could lead to interventions, even preventative interventions that may improve individuals economic and over quality of life.

Pain across the Lifespan

A number of studies have examined the effects of age on pain (i.e., pain across the lifespan). Gagliese (2009) noted an increase in studies looking at age and pain, and argued that one reason includes the intuitive assumption that pain experiences do in fact seem to differ in different age groups. The differences in pain due to age could be related to varying pain sensitivity (Cole, Farrell, Gibson, & Egan, 2010), pain thresholds (Lautenbacher, Kunz, Strate,

Nielsen, & Arendt-Nielsen, 2005), different perceptions and reporting of pain (Shega, Tiedt, Grant, & Dale, 2014; Zarit, Griffiths, & Berg, 2004), and so on.

Cole et al. (2010) collected data from healthy young adults (23 to 29 years old) as well as older adults (75 to 83 years old) to compare the effects of age on pain processing via pain sensitivity while examining brain activity. Results indicated that younger adults were less sensitive to pain than older adults along with differences between the two age groups in brain volume. Although in a laboratory setting, this study leads to interesting questions about how pain sensitivity might decrease over the lifespan.

Other researchers point to methodological differences as a possible explanation as to why perceptions of pain results seem to contradict each other in the literature. To that point, Lautenbacher et al. (2005) tested a variety of pain-induction methods (somatosensory thresholds, experimental pain, spatial summation, and temporal summation) and their relation to age. Older adults had higher thresholds for somatosensory thresholds, yet lower thresholds on pressure pain. Heat methods led to no differences based on age along with supra-threshold spatial summation whereas temporal summation findings were that older adult results are higher in temporal heat tasks, but not pressure (Lautenbacher et al., 2005).

In another study examining the influence of chronic pain on overall health, Wittink et al. (2006) found that although slight differences existed between younger and older adults, chronic pain affected both age groups. Older adults did report more problems related to physical ailment in comparison to less reported psychological malady (Wittink et al., 2006). Shega et al. (2014) utilized data from the National Social Life, Health, and Aging Project (NSHAP) to study pain in aging adults from an epidemiological perspective. Results indicated that male and female older adults differed slightly in terms of where their pain was most experienced. Overall, pain was

reported to be higher in women than men; age predicted location of pain in as age increased, so too did head and chest pain versus lower aged participants experienced pain more in other areas (Shega et al., 2014). Molton, and Terrill (2014) reviewed the literature to describe different components and mechanisms that could impact the change in pain experiences over the lifespan. Constructs reviewed included neurological and biological, differences in cognition, coping, and social support systems in older adults. Molton and Terrill (2014) concluded that more could be done to accurately train and help psychologists to be able to assist older adults in coping with pain.

When it comes to the extremes of age, research has been conducted to examine the experience of pain in the “oldest old” (i.e., 85 years old and older). One study followed elderly adults ($M = 86.7$ years old) for two years and investigated the prevalence of pain among these adults along with examining what may contribute to their pain and how it changed over the two years. The number of people experiencing pain increased over the two-year span (from 33% to 40%) and most of those with pain experienced it chronically. Another study assessed pain in older adults broadly (65 years and older), but the sample included about 800 centenarians as well (Zyckowska, Szczerbińska, Jantzi, & Hirdes, 2007). This study found that with age, pain decreased, particularly for those in “home care or institutional settings” (Zyckowska et al., 2007, p. 172).

All in all, more should be learned about the associations between age and pain. One could argue that an interdisciplinary approach (i.e., looking at psychological components of pain) could help explain more of the story behind age and pain.

Lifespan Considerations for Fear of Pain

Although the literature describing *pain* from a variety of age-groups is well-studied and well-documented, limited research has examined lifespan perspectives on *fear of pain*. In one example study, aging was shown to affect pain perception (Cole et al., 2010) and possibly the expression or description of pain. Cook, Brawer, and Vowles (2006) found that older adults (55 and older) had lower levels of pain-related fear than their middle-aged counterparts and fear of pain was replicated as a mediator of pain in older adults. Ward and Thorn (2006) submitted an editorial that primarily criticized the work of Cook et al. (2006), stating that they may have over-interpreted the results of their structural equation model. Despite the criticisms, there seems to be a significant association of fear of pain as a mediator in a multiple age groups.

Another study examining the effects of age on pain-related fear assessed the differences between fear of pain in younger and older adults as well as the difference between fear of pain and fear of falling (Williams, Hadjistavropoulos, & Asmundson, 2005). Attentional biases toward pain stimuli in younger adults also carries over into older adulthood were examined and it was found that fear of pain and fear of falling are fundamentally different constructs from each other. Additionally, Williams et al. (2005) found that fear of pain remains an important construct and recommended that future research utilizing the fear-avoidance model should include attention to both pain-related fear and fear of falling.

Given the relation between age and pain, as well as the relation between pain and fear of pain, one could argue that age could be related to individual perception or expression of pain-related fear. Some evidence exists when considering fear more broadly. The etiology and/or maintenance of fear can begin as early as infancy with childhood experiences of trauma and the relation to attachment (Cassidy & Mohr, 2001). In terms of specific studies looking at age and

fear of pain, Albaret, Sastre, Cottencin, and Mullet (2004) collected data from four groups: adolescent/very young adults (17-24 years-old), young adults (25-35 years-old), middle-aged (36-55 years-old), and elderly (56-80 years-old). The French version of the Fear of Pain Questionnaire-III (McNeil & Rainwater, 1998) was shown to function similarly across different age groups. Additionally, it was found that exposure to pain is associated with decreased fear of pain (Albaret et al., 2004). Although few studies have taken a lifespan perspective, others have studied individual age groups and pain-related fear (Crombez et al., 1999; Hursey & Jacks, 1992; McCracken et al., 1992; Waddell et al., 1993).

Using the Pain Anxiety Symptoms Scale (PASS), McCracken et al. (1992), examined the association between a construct similar to pain-related fear, that of anxiety related to pain, with the pain experience in small sample ($n = 38$) of older adults ($M = 73.24$ years old). Results indicated a possible negative association between pain-related anxiety and health status.

Martin, Hadjistavropoulos, and McCreary (2005) conducted an interesting study that found results contrary to others in this area. Martin et al. (2005) examined fear of pain and fear of falling in a variety of age groups and found no statistically significant correlation between fear of falling and age. Likewise, some evidence for pain-related fear was also unclear as to whether age differences existed (Martin et al., 2005). Additional research is needed in this area to assess possible non-linear relationships or possible subgroups in which age does perhaps matter for how individuals rate their fear of pain.

Although it was not necessarily a study of the effects of age on pain-related fear, Sieben et al. (2005) conducted one of the first studies examining fear of pain across time. The authors utilized regression models and post-hoc analyses to assess the durability of the fear-avoidance model over time. Results indicated that there were no relations between the avoidance of fear

(i.e., fear of pain) and long-term chronic pain (Sieben et al., 2005). Though time has shown to be associated with fear-avoidance changes, little is known about the specifics relation between age and fear of pain. Given some of the possible limitations to their study, other studies (both exploratory cross-sectional and prospective studies) are needed to assess how pain-related fear is influenced by age. Ideally, more prospective studies should be conducted in attempts to address this issue.

Along the lines of the last study, although fear of pain may have been assessed in different age groups, little to no research has been conducted to look at the possible age differences for fear of pain and how it changes over the lifespan. Additionally, little research has been conducted to look at intergenerational changes in fear of pain.

Statement of the Problem

It is well established that experience of pain changes with age, yet little empirical evidence exists to demonstrate whether and how fear of pain varies based on age across the adult lifespan. This thesis aimed to facilitate understanding about how fear of pain is experienced by individuals based on age differences across the adult lifespan. This work could facilitate additional studies that identify potentially optimal periods of one's life where intervention is most suitable for maladaptive behaviors and ultimately, the experience of pain itself. For example, since fear often leads to avoidance of adaptive behaviors (i.e., promotes maladaptive behaviors), this study could help provide a clearer picture of when adults are most prone to avoidant behavior, allowing for interventions to reduce fear and promote healthier habits and well-being.

In order to assess how fear of pain changes across the lifespan, one primary focus was to examine cross-sectional associations between age and fear of pain. Based on preliminary

analyses on a subset of the data, it was hypothesized that a significant non-linear (i.e., would be either a quadratic or cubic function) relationship would exist between age and pain-related fear. In addition, it was hypothesized that latent classes exist and that age and sex would predict class membership. To test this hypothesis, exploratory analyses (latent class analyses) were conducted to determine whether underlying latent classes of participants were associated with individual differences based on age and/or sex..

Method

Participants and Procedure

Existing archival datasets including individual data ($n = 3,460$) previously collected about fear of pain, along with a new supplement of participants ($n = 828$) from Amazon's Mechanical Turk (MTurk; www.mturk.com) were utilized to provide a robust sample ($N = 4,288$) to assess the targeted research questions. The archival datasets included the Fear of Pain Questionnaire-9 validation sample of undergraduate psychology students from two institutions (Oklahoma State University and West Virginia University) and chronic pain patients (McNeil et al., 2018), adult participants from the Center for Oral Health Research in Appalachia (COHRA1) study (Polk et al., 2008), an oral diagnostic sample (Randall, Shulman, & McNeil, 2014), and two national samples from a previous study about oral health values that also utilized MTurk (Edwards & McNeil, 2018). Each of these studies included data from different time periods (range = 1995-2017).

The new data were collected via MTurk as part of a larger study of psychosocial correlates of oral health and disease. MTurk has become an increasingly popular mechanism for collecting large amounts of data, from all over the world, in an efficient and relatively inexpensive manner. MTurk samples tend to be more representative than traditional college or

convenience samples (Berinsky, Huber, & Lenz, 2012) and previous work has shown the ability to recruit up to about 300 participants in a single day (Berinsky et al., 2012). Concerns about the psychometrics, including reliability, internal and external validity, and general acceptance of MTurk data have been addressed elsewhere (Berinsky et al., 2012; Buhrmester, Kwang, & Gosling, 2011). MTurk data does come with limitations (e.g., the population is mostly younger, a generally more liberal group of participants), but the ability to restrict and define certain characteristics (e.g., to specific age groups, or just individuals from the United States) can alleviate some of these concerns (Berinsky et al., 2012). All in all, MTurk has been shown to be a reputable alternative to, and depending on the research question, better than other traditional data collection methods (e.g., college samples; Berinsky et al., 2012; Buhrmester, et al., 2011). Additionally, TurkPrime (Litman, Robinson, & Abberbock, 2017), an online tool that integrates seamlessly with MTurk to help streamline the MTurk data collection process, was used in recruitment and data collection for this project. TurkPrime allowed for a level of automation during data collection.

Although a normally distributed and stratified sample of multiple adult age groups was collected (in order to maintain a normal distribution of age), a primary objective of the new MTurk data collection was to obtain additional older adults (65 years old and older; American Psychological Association, 2017) in order to better describe the fear of pain age differences across the adult lifespan. The mean age of the existing archival data was 35.9 years ($SD = 12.9$; range = 18-98), and the targeted mean of the new data collection was to be around 45 years of age. Particular attention was paid to increase the number of participants age 65 years and older to use for age group comparisons.

The new MTurk data collection began in October 2017. A number of waves of recruitment were initiated starting with requesting participants age 18 years and older. After the first five or six people an error was found in the way participant income was asked and was corrected before additional participants were collected. Likewise, after initially starting by collecting only “master level” MTurk workers, this was changed after about 30 participants to be people with at least 100 hits experience and a 95% approval rating. Collection criteria was later adjusted to people with 500 hits and 95% approval rating to ensure participant sincerity and avoid response bias. The feature in Turk Prime to only collect from certain age groups did not function at the beginning and so an IRB amendment was created to have the advertisements state the targeted age groups and a variable was created to track those that were younger than the proposed age.

By December 2017, 155 participants had been collected and all new changes with the IRB had been approved. Data collection resumed at this point by increasing the targeted age group (e.g., 18 years and older, 35 years and older, 45 years, 60 years and so on) and careful attention was paid to ensure normality of data based on age.

Measures

Each of the archival datasets included age and sex as variables. Other demographic variables (i.e., race/ethnicity, income, education) were available in different forms and utilized for various post-hoc analyses. The new MTurk dataset also included demographics of age, sex, race/ethnicity, income, and education.

Fear of Pain Questionnaire – 9 (FPQ-9). A variety of pain-related fear assessments have been developed (FPQ-III; McNeil & Rainwater, 1998; PASS; McCracken et al., 1992). This study (including the archival datasets and the new data collected) utilized the Fear of Pain

Questionnaire – 9 (FPQ-9; McNeil et al., 2018). The FPQ-9 is a short form of, and mirrors its parent version, the Fear of Pain Questionnaire – III (McNeil & Rainwater, 1998) and includes three subscales: fear of severe pain, fear of minor pain, and fear of medical or dental pain. Both the FPQ-III and the FPQ-9 have had a number of studies in a number of cultural and contextual contexts examining their psychometric value (Albaret, Sastre, Cottencin, & Mullet, 2004; Roelofs, Peters, Deutz, Spijker, & Vlaeyen, 2005; Osman, Breitenstein, Barrios, Gutierrez, & Kopper, 2002; van Wijk & Hoogstraten, 2006). Data from the FPQ-9 has been indicative of good reliability (coefficient alpha = .72-.94) and produced adequate evidence for overall construct validity (see McNeil et al., 2018).

Validity items. Given the importance of age for this study, questions intended to ensure valid responses to age were included in the MTurk survey. Each participant was asked their age in years two separate times, and were asked their birth year once. The participants age was then calculated using their birth year subtracted from 2017 to derive another age variable. The three age variables were then compared and if all three did not match, the participant data was not included in the final analyses. In addition, after initial data collection began ($n = 155$), and additional information was learned about the best practices for MTurk data collection, additional general validity items were added to the overall survey. Adding the validity items to the overall survey was in effort to protect against response biases or participants who just randomly filled out the survey. The validity items, both age-related and in general, are included in the appendix.

Data Analyses

A multi-tiered analytic approach was used to examine the relation between age and pain-related fear. Analyses included structural equation modeling, simple regression models, and latent class analysis to extract subgroups or classes of individuals. Those classes were then

explored using logistic regression, ANOVA, and Chi-square analyses. Structural equation modeling (SEM) is a statistical analysis framework that combines the best of psychometrics, regression, and path analysis (Keith, 2014; Wang & Wang, 2012). Ordinary least squares regression models assume variables (including self-report measures) to be perfectly measured (no error), whereas SEM first utilizes factor analysis to create latent variables that take measurement error into account and which are used in the full regression models resulting in more accurate coefficients and *p*-values (Wang & Wang, 2012). Other basic assumptions in SEM are the same as multiple linear regressions, namely normality of data, independence of data, variances to be relatively equal, no evidence of extreme multi-collinearity, and linearity of data (Keith, 2014). Assumptions for this project were spot-checked utilizing basic descriptive analyses, frequency counts, and histograms.

Missing data. All missing values for fear of pain subscales/total score, age, and sex were dummy-coded as “1” for missing and “0” for not missing. Descriptive data of missingness for age, sex, and FPQ-9 subscales are displayed in Table 2 and are provided in the results section. The dummy-coded variables were correlated with study variables to assess for significant relationships. Given a couple significant correlations, missing at random (MAR) was assumed and a full information maximum likelihood (FIML) estimator was used to account for any problems with missing data in the SEM.

Descriptive statistics. Descriptive statistics were included to describe sex, age, race/ethnicity (where available), income (where available), education (where available), and the type of sample (e.g, undergraduate students, chronic pain, MTurk). Only participants from the MTurk study (originally $n = 1,033$) that responded to and matched on age items, responded to and correctly responded to the general validity items, were included in the final analyses.

Structural equation model (SEM). To examine the relation between fear of pain and age, a confirmatory factor analysis (CFA) of the FPQ-9 subscales (i.e., fear of severe pain, fear of minor pain, fear of medical and dental pain) was first conducted. FPQ-9 subscales (fear of severe pain, fear of minor pain, and fear of medical/dental pain) were then regressed on age and sex. A second SEM was conducted with FPQ-9 total scores modeled as a higher order latent variable regressed on age and sex. SEM analyses were conducted using MPlus 8.0 (Muthén & Muthén, 1998-2017). After the model was assessed linearly, age was squared and analyzed as a quadratic term and then cubed and analyzed as a cubic term to assess the possible curvilinearity fit of the model. Due to issues of extreme variances for age, MPlus was unable to estimate the quadratic or cubic models. Instead, four separate ordinary least squares regressions (one for each FPQ-9 subscale and total score) were conducted with quadratic and cubic terms in SPSS 25.0 (IBM).

Latent class analysis (LCA). Exploratory factor analyses (EFA) use advanced mathematical techniques to determine underlying groupings or factors of variables (i.e., factors that exist using columns of data), whereas latent class analysis rely on advanced mathematics to detect unique groups of individuals (i.e., factors existing among the *rows* of data; Wang & Wang, 2012).

LCA differs from the typical cluster analyses in that LCA provides a more empirical method for determining how many classes (“clusters”) to extract via certain statistical indicators (Wang & Wang, 2012). LCA utilizes principles of mixture structural equation modeling where the latent classes extracted allow to explain some of the variance in some dependent variable, in this case pain-related fear (Heck & Thomas, 2015). In short, LCA provides an empirically-

supported method for determining if unknown groups may be contributing to individual differences in variance related to some outcome variable.

LCA was conducted to explore whether unique classes exist and respond differently to the FPQ-9. These analyses also were conducted in Mplus 8.0 (Muthén & Muthén, 1998-2017). The number of latent classes were determined after running the various models in an iterative process based on the best fitting model (BIC, entropy, and BLRT; Jung & Wickrama, 2008; Wang & Wang, 2012). First, an unconditional LCA (no covariates) was conducted to extract classes based on responses to the FPQ-9 subscales and the total score. Covariates of age and sex were then included (i.e., the conditional model) and a multinomial logistic regression using the covariates was used to predict class membership. Likewise, in an effort to describe the different classes, age and sex were calculated for each class to describe the different classes.

Results

Assumptions and Missing Data

Assumptions were deemed adequately met especially given robust nature of regression models for all variables, though age was positively skewed (i.e., greater amount of younger participants than older; see Figure 1 for a histogram of age data). For the new MTurk dataset ($n = 1,033$), 73 (7.1%) participants failed or did not respond to the first validity item, 83 (8.0%) to the second, 89 (8.6%) to the third, and 79 (7.6%) to the fourth. The number of participants who failed or did not respond to the age validity items (i.e., three age variables did not match) was 173 (16.7%). The first 155 MTurk participants were not presented with the validity items and were thus assumed valid responses. Overall, only participants who answered all validity items and answered correctly, plus the 155 were included in the study ($n = 828$). Independent samples t -tests and a Chi-square test were conducted to assess differences in age, sex, and FPQ-9 scale

scores of those included in the study and those excluded due to validity item responses.

Significant differences were found based on age ($t(929) = 6.31, p < .001$) such that those with valid data were older on average ($M_{valid} = 48.0, SD = 12.7$) compared to those with non-valid data ($M_{non-valid} = 39.7, SD = 12.3$). Participants with valid data differed on the FPQ-9 total score ($t(993) = -4.48, p < .001$), on fear of minor pain ($t(223.57) = -6.32, p < .001$), and on fear of medical/dental pain ($t(993) = -5.08, p < .001$). Those with valid data had lower total scores ($M_{valid} = 26.1, SD = 6.3; M_{non-valid} = 28.6, SD = 6.5$), lower fear of minor pain ($M_{valid} = 7.0, SD = 2.5; M_{non-valid} = 8.5, SD = 2.8$), and lower fear of medical/dental pain ($M_{valid} = 7.8, SD = 2.7; M_{non-valid} = 9.0, SD = 2.9$). Participants with valid responses did not differ from those with non-valid responses on fear of severe pain ($t(993) = 1.08, p = .28; M_{valid} = 11.3, SD = 2.6; M_{non-valid} = 11.1, SD = 2.6$). Those with valid data differed on sex such that there were more females (58.9%) than males (41.1%) in the valid data and fewer females (45.6%) than males (54.4%) among those with non-valid responses ($\chi^2_{\text{Pearson}}(1, N = 931) = 6.6, p = .01$).

In terms of the full combined dataset ($N = 4,288$), a correlation table displaying missingness in the age, sex, FPQ-9 subscales and total score correlated with the variables is displayed in Table 1. The only significant (and relevant) correlations were between missingness in fear of minor pain and fear of severe pain ($r(4086) = -0.047, p < .01$) along with missingness in fear of pain total scores and fear of severe pain ($r(4086) = -0.041, p < .01$). That is missing data in fear of minor pain and fear of pain overall were associated with how individuals responded to fear of severe pain. Overall, out of the total sample of 4,288, 13 had missing sex data. For the fear of severe and fear of minor pain subscales, 200 had missing data on at least one item and were thereby marked as missing. For the fear of medical and dental pain, 199 were missing and for the total score, 246 individuals had missing data. For the ordinary least squares

regressions, those with missing data were excluded from those analyses (i.e., listwise deletion). For the SEM models, data were treated as missing at random (MAR) and missingness was accounted for via full information maximum likelihood (FIML) using the MLR estimator in MPlus (Muthén & Muthén, 1998-2017).

Descriptive Statistics

Table 3 displays the descriptive statistics for each of the archival data, new MTurk data, and the combined dataset. Overall, the total sample ($N = 4,288$) had a mean age of 37.5 ($SD = 14.0$, $Range = 18.0-98.0$) and included 2,528 females (59.1%) and 1,747 males (40.9%). The overall mean for the FPQ-9 Total was 24.0 ($SD = 7.4$; $Range = 9.0-45.0$); for fear of severe pain was 10.1 ($SD = 14.0$; $Range = 3.0-15.0$), fear of minor pain was 6.2 ($SD = 2.5$; $Range = 3.0-15.0$), and fear of medical and dental pain was 7.7 ($SD = 3.0$; $Range = 3.0-15.0$).

Structural Equation Model (SEM)

Results of the confirmatory factor analysis (three subscales as latent variables with the indicators each) were indicative of a well-fitting factor structure. After initially testing the full SEM with requested modification indices, items 1 and 2 of the FPQ-9 were allowed correlate to improve overall model fit. The FPQ-9 can be used with the individual subscales or as a total score, so it is expected that some of the items may correlate with each other, as did items 1 and 2. Fear of severe pain was significantly associated with age ($\beta = 0.135$, $p < .001$) and sex ($\beta = -0.181$ $p < .001$), such that males have lower fear of severe pain than that of females. Fear of minor pain also was associated with age ($\beta = 0.107$, $p < .001$) and sex ($\beta = -0.092$ $p < .001$) with males lower than females. Fear of medical pain was negatively associated with age ($\beta = -0.083$, $p < .001$), indicative of increased age being associated with lesser levels of medical and dental pain-related fear. Sex was again associated with fear of medical and dental pain such that males

have lower fear of severe pain than that of females ($\beta = -0.215$, $p < .001$). The full structural equation model is displayed in Figure 2.

A similar model was tested using the higher order factor structure of the FPQ-9 with the three subscales loading onto a single total score latent variable. Results of a CFA testing just the measurement portion also were indicative of a well-fitting model. The CFA excluded 166 individuals who did not respond to any FPQ-9 item, but those individuals were included in the full SEM since they did respond to covariate information. The total score latent variable was then regressed onto age and sex in the full model. Fear of pain total scores were significantly associated with age ($\beta = 0.069$, $p < .001$) indicating that as age increases, so too does fear of pain. Sex also was associated with fear of pain total scores such that males have lower fear of pain than that of females ($\beta = -0.193$, $p < .001$). The full higher order SEM is displayed in Figure 3.

Because variances for quadratic age and cubic age were too large for MPlus to estimate the full SEM, ordinary least squares regressions were conducted to examine the curvilinear relations between age and fear of severe pain, fear of minor pain, fear of medical/dental pain, and the FPQ-9 total score. All models used sex as a covariate and missing data was handled for these analyses using listwise deletion. Age was associated in both the quadratic ($\beta = 2.076$, $p < .001$) and cubic ($\beta = -1.278$, $p < .001$) models for fear of severe pain. Sex also was related such that males have less fear of severe pain than that of females ($\beta = -0.168$, $p < .001$). For fear of minor pain, the quadratic and cubic terms were non-significant, though the linear model of age was similar to that seen in the SEM model ($\beta = 0.094$, $p < .001$). Males still showed lower levels ($\beta = -0.076$, $p < .001$) and females greater levels. Fear of medical/dental pain was associated with both the quadratic ($\beta = 1.798$, $p = .001$) and cubic ($\beta = -0.974$, $p = .001$) terms. Interestingly,

when just the quadratic term was added, it was not significant, but once the cubic term was added, it became significant (better fit). Sex also was a significant contributor ($\beta = -0.181, p < .001$) with males lower levels of fear of medical/dental pain and females greater. The FPQ-9 total model resulted in a similar pattern in which total scores were associated with both quadratic ($\beta = 1.904, p = .001$) and cubic ($\beta = -1.120, p < .001$) terms. Sex was again significant ($\beta = -0.176, p < .001$) such that males were more likely to have lower fear of pain total scores and females greater total scores. Figures 4 and 5 include scatterplots with best fitting and interpolation lines to show the relation of age and the FPQ-9 subscales and total scores (figures are stratified by sex).

Latent Class Analysis (LCA)

Results of the LCA indicated a five-class unconditional model fit best. Table 6 displays the fit statistics for each of the unconditional models tested. After including the covariates of age and sex, the results of the conditional LCA were indicative of a five-class model fitting best (see Table 7 and Figure 6). The five classes included a “generally low fear of pain” class (17.1%), a “typical fear of pain” class (30.9%), a “high minor pain” class (5.1%), a “high severe pain” class (38.1%), and a “generally high pain” class (8.9%).

Results of the multinomial logistic regression showed age significantly predicted class membership, such that increased age was associated with a greater likelihood of being in generally high fear of pain class compared to the high minor pain class ($b = 0.047, p < .001$). Likewise, males were less likely to belong to class the generally high fear of pain class compared to the high minor pain class ($b = -1.290, p < .001$).

Once class membership was identified, average age and percent of males and females for each class were explored. The “high minor pain” class had the lowest mean age ($M = 32.0, SD$

=12.3) and the “generally high fear of pain” class had the highest mean age ($M = 41.1$, $SD = 13.5$). A one-way ANOVA was conducted with Tukey’s post-hoc test to examine the differences between class membership and the square-root transformation of age (due to significance on the homogeneity of variances test). The “high minor pain” class differed significantly from all other classes except for the “typical” class ($F(4,4099) = 49.90$, $p < .001$). The “high minor pain” class also had the highest percentage of males (60.6%) and the generally high class had the lowest percentage of males (28.4%; $\chi^2_{\text{Pearson}}(4, N = 4,104) = 206.4$ $p < .001$).

Discussion

Given the prior associations between age and pain, pain perception, and pain experiences, this study was aimed to examine the relation of age and pain-related fear. Data were collected from individuals across the adult lifespan, combined with other archival datasets, and age was used to predict fear of pain. Using a multi-tiered approach to analyze the data to look at general trends as well as specific potential subgroups, age was associated with fear of pain in a number of ways, each with implications for additional research, exploration, and consideration.

First, a general theme from the results of the SEM indicated the interesting relation between age and the different types of fear of pain, all while taking into account the variance from the other types. That is, when examined linearly, although older age was associated with greater fear of severe and minor pain, increased age was associated with lower fear of medical or dental pain. This is interesting considering an “exposure” framework (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014). On average, 87.9% of patients over the age of 65 have been reported to have one or more visits to a health care generalist compared to 65.1% of 18 to 64 year olds and 83.8% of 2-17 year olds (National Center for Health Statistics, 2016). Even with well visits made in the pediatric years, older adults visit generalists more often than other cohorts

do. It could be that, as time goes on, older adults experience more medical and dental appointments than younger individuals and are therefore more “used to it”. The same trend holds for visits to specialists and eye doctors and for more overnight hospital visits over time for both males and females (National Center for Health Statistics, 2016). Interestingly, adults 65 years and older have the lowest percentage of individuals with a visit to a mental health provider (4.8%) or a dentist (62.7%) compared to 18-64 year olds (8.8% and 64.0%) and 2-17 year olds (8.7% and 84.7%) respectively (National Center for Health Statistics, 2016). Although older adults have higher rates of medical visits, they visit dentists less often than do other age cohorts. Additional research is needed in this area to further explore relations between visits to general and oral healthcare providers, age, and fear of medical and dental pain.

The increasing rates of fear of severe pain in older adults could be related to the etiology or consequences of the painful experiences. For example, severe bodily pain may be indicative of an acute pathological process, which may spawn fearfulness. Or, perhaps the fear associated with breaking a bone (e.g., hip) could trigger anxiety or fears about loss of mobility. The meaning of pain therefore has profound implications for the older adult and quality of life (Beecher, 1956). Given prior literature (Martin et al., 2005; Williams et al., 2005), perhaps fear of falling operates as a mediating variable, or partially explains the relation between age and fear of severe or minor pain. That said, prior work has shown how some individuals with low fear of pain continue to have low fear of pain even after experiencing painful events (McCracken et al., 1993). Based on these findings, it is unclear if the direct consequence of experiencing pain truly changes one’s pain-related fear. More could be done to explore these relations and help to understand the quality of life-related variables affect anxiety or fear around painful experiences.

The non-linear regression models indicated a cubic relation between age and fear of severe pain, fear of medical and dental pain, and overall fear of pain. Though significant, the relation was not dramatic, but showed a slight increase in fear during the twenties and then a steady decrease after about age 65 years. Decision-making abilities and executive functioning continue to mature well into the twenties (Johnson, Blum, & Giedd, 2009), which could be associated with one's disposition toward painful experiences. Perhaps as executive functioning and decision-making abilities facilitate "wiser" decisions, fear of pain becomes a type protective factor aiding individuals to avoid more readily harmful situations.

Analyses for both linear and non-linear models were conducted, each with its own benefits and limitations. An advantage to the linear model is interpretability. That is, one can assess general trends. On the other hand, the cubic relation allows for more of a nuanced approach, but is really only easily understood by examining a figure plotting out the cubic function. In addition, the full structural equation model (that was linear); takes measurement error into account and all regressions are conducted simultaneously, thus accounting for an individual's different types of pain-related fear. The structural equation model is thus perhaps a more "accurate" approach given the accounted for error that has been shown to result in more accurate beta estimates and *p*-values (Wang & Wang, 2012). The cubic relation, however, may be more telling as to the course of pain-related fear. Though, given the cross-sectional nature of this study, more would need to be done in a prospective manner to truly assess the trajectory of fear of pain.

A strength of this study was the detailed and nuanced perspective via latent class analysis on how pain-related fear may vary from individual to individual and from group to group. Five different classes represented the variety of individuals, and how they responded to the FPQ-9.

Particularly of interest was the class of individuals who reported minimal fear of pain across all subscales. This class would be interesting to investigate further given that some level of fear of pain would be expected, even as an adaptive protective factor. Two other classes followed what would be expected by having elevated levels on fear of severe pain, lower levels on fear of minor pain, and somewhat elevated levels of fear of medical/dental pain. There also was a class that reported the highest levels of all three subscales. This group was the oldest on average out of all the classes and was predominantly females. The last group was the smallest, but also interesting given the descriptive post-hoc analyses. Though only about 5% of the sample, these individuals had the youngest mean age and opposite of the last class described, was comprised of mostly males. This could suggest that a subgroup of younger males was more fearful of fear of minor pain than their counterparts. Given potential limitations in extracting the classes and correctly assigning class membership, additional studies should seek to replicate the findings in this study. Additionally, further analyses should be conducted to better describe this sub-population. It may be that they have had experiences that make them more fearful of normally less intimidating pain.

Limitations

This study should be understood in light of its limitations. First, 205 participants from the new data collection were not included due to missing data or non-valid responses on a series of validity items. As the missing data analyses indicated, there were significant differences in age, sex, and fear of pain levels between the valid responders and the non-valid responses. MTurk can include, however, individuals who simply respond randomly and as quickly as possible to complete as much work as possible and get paid. Indeed, this is the reason for the inclusion of so many validity items. Participants also could have been untruthful about their age, given the

advertisements in the MTurk data collection indicated a specific age minimum. Asking age three times (twice about age in years and once birth year), together with validity items were intended to protect against this. Likewise, the new data collection iteratively increased the requirements for prior work on MTurk (eventually increasing completed hits to 500 and approval rating of 95%). Though there is no way to know for sure that the newly collected MTurk data was perfectly valid, the validity items and other requirements protected against the potential response bias.

The sample for this study was comprised of multiple archival datasets as well as newly collected data. The overall sample was diverse in the time period it was collected and the type of individuals from which it was collected. That is, some of the fear of pain data came from undergraduates at two different universities from the 1980s and from the last 10 years or so. Likewise, some participants were chronic pain patients, while others were from a more representative USA online sample. While advantageous for statistical purposes (i.e., greater variability), one could argue that age is associated with pain-related fear in different ways in different time periods or for different individuals (e.g. chronic pain patients versus undergraduate students). It could be that the experience of pain and the treatment of pain were so different a couple decades ago from today to be difficult to include in one analysis (i.e., undergraduates from 20 years ago may respond to fear of pain items differently than those today). While these are potential limitations, overall, the variability was a strength and helped in generalizing overall averages for a diverse sample over multiple periods of time. Additional studies should be conducted, however, to further explore how fear of pain is affected by age in subpopulations such as chronic pain patients or from different time periods.

Limitations existed as well in the statistical analyses for this study. Given constraints in extreme variance estimates, structural equation modeling was not able to be used to look at the quadratic and cubic functions of age on fear of pain. Likewise, issues with local maxima and need for increased LRT starts in the latent class analyses should be considered when interpreting the class membership results/percentages. Although the models terminated normally, the warnings could indicate that MPlus had a difficult time assigning class membership. Again, additional studies and analyses should be conducted to replicate the findings in this study and to validate class membership groups, especially the group with elevated fear of minor pain.

Conclusions

Fear of pain varies with age across the adult lifespan. Additionally, different types of pain-related fears are manifested differently depending on age. Fear of severe and minor pain are positively associated with age. Fear of medical pain, however, appears to be negatively associated with age. There also seems to be a subgroup of younger males who tend to have higher levels of fear of minor pain compared to others. More work is needed to replicate and prospectively test the effects of age on fear of pain.

References

- Albaret, M. C., Sastre, M. T. M., Cottencin, A., & Mullet, E. (2004). The Fear of Pain questionnaire: Factor structure in samples of young, middle-aged and elderly European people. *European Journal of Pain, 8*, 273–281. doi: 10.1016/j.ejpain.2003.09.005
- American College of Emergency Physicians (2009). “Optimizing the treatment of pain in patients with acute presentations”. Retrieved from <https://www.acep.org/Clinical-Practice-Management/Optimizing-the-Treatment-of-Pain-in-Patients-with-Acute-Presentations/>
- American Psychological Association. (2017). “Psychology and aging”. Retrieved from <https://www.apa.org/pi/aging/resources/guides/aging.pdf>.
- Asmundson, G. J. G., Norton, P. J., & Norton, G. R. (1999). Beyond pain: The role of fear and avoidance in chronicity. *Clinical Psychology Review, 19*(1), 97–119.
[http://doi.org/10.1016/S0272-7358\(98\)00034-8](http://doi.org/10.1016/S0272-7358(98)00034-8)
- Beck, A. T., Steer, R. A., & Brown, G. K. (1996). Manual for the Beck Depression Inventory-II. San Antonio, TX: Psychological Corporation.
- Beecher, H. K. (1956). Relationship of significance of wound to pain experienced. *Journal of the American Medical Association, 161*, 1609-1613.
- Benedetti, F., Thoen, W., Blanchard, C., Vighetti, S., Arduino, C. (2013). Pain as a reward: Changing the meaning of pain from negative to positive co-activates opioid and cannabinoid systems. *Pain, 154*, 361-367.
- Berinsky, A. J., Huber, G. A., & Lenz, G. S. (2012). Evaluating online labor markets for experimental research: Amazon.com’s mechanical turk. *Political Analysis, 20*(3), 351–368. <http://doi.org/10.1093/pan/mpr057>

- Buer, N., & Linton, S.J. (2002). Fear-avoidance beliefs and catastrophizing: Occurrence and risk factor in back pain and ADL in the general population. *Pain* 99, 485-491. doi: 10.1016/S0304-3959(02)00265-8.
- Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality, data? *Perspectives on Psychological Science*, 6(1), 3–5. <http://doi.org/10.1177/1745691610393980>
- Burri, A., Marinova, Z., Robinson, M. D., Kühnel, B., Waldenberger, M., Wahl, S., Kunze, S., Gieger, C., Livshits, G., & Williams, F. (2016). Are epigenetic factors implicated in chronic widespread pain? *PLoS ONE*, 11(11), 1–13. <http://doi.org/10.1371/journal.pone.0165548>
- Carter, L. E., McNeil, D. W., Vowles, K. E., Sorrell, J. T., Turk, C. L., Ries, B. J., & Hopko, D. R. (2002). Effects of emotion on pain reports, tolerance, and physiology. *Pain Research and Management*, 7, 21-30.
- Cassidy, J., & Mohr, J. J. (2001). Unsolvable Fear, Trauma, and Psychopathology: Theory, Research, and Clinical Considerations Related to Disorganized Attachment Across the Life Span. *Clinical Psychology: Science and Practice*, 8(3), 275–298. doi.org/10.1093/clipsy/8.3.275
- Cole, L. J., Farrell, M. J., Gibson, S. J., & Egan, G. F. (2010). Age-related differences in pain sensitivity and regional brain activity evoked by noxious pressure. *Neurobiology of Aging*, 31(3), 494–503. <http://doi.org/10.1016/j.neurobiolaging.2008.04.012>
- Cook, A. J., Brawer, P. A., & Vowles, K. E. (2006). The fear-avoidance model of chronic pain: Validation and age analysis using structural equation modeling. *Pain*, 121(3), 195–206. <http://doi.org/10.1016/j.pain.2005.11.018>

- Craig, K. D., Prkachin, K. M., & Grunau, R. V. E. (2001). The facial expression of pain. In D. C. Turk and R. Melzack (eds.), *Handbook of Pain Assessment*, 2nd edition, pp. 153-169. New York, NY: Guilford.
- Craske, M. G. (2003). *Origins of phobias and anxiety disorders: Why more women than men?* Oxford, UK: Elsevier Ltd.
- Craske, M. G., Treanor, M., Conway, C. C., Zbozinek, T., & Vervliet, B. (2014). Maximizing exposure therapy: An inhibitory learning approach. *Behaviour Research and Therapy*, 58, 10-23.
- Crombez, G., Vlaeyen, J. W., Heuts, P. H., Lysens, R. (1999). Pain-related fear is more disabling than pain itself: Evidence on the role of pain-related fear in chronic back pain disability. *Pain*, 80, 329-339. doi:10.1016/S0304-3959(98)00229-2.
- DeFoe, D. (1726). *The Political History of the Devil, As Well Ancient as Modern: In Two Parts*. London: Black Boy in Paternoster Row. p. 269.
- Edwards, C. B. & McNeil, D. W. (2018). *Development of the Oral Health Values Scale*. Manuscript in preparation.
- Edwards, C. L., Fillingim, R. B., & Keefe, F. (2001). Race, ethnicity and pain. *Pain*, 94(2), 133–137. [http://doi.org/10.1016/S0304-3959\(01\)00408-0](http://doi.org/10.1016/S0304-3959(01)00408-0)
- Fillingim, R. B., King, C. D., Ribeiro-Dasilva, M. C., Rahim-Williams, B., & Riley, J. L. (2009). Sex, gender, and pain: A review of recent clinical and experimental findings. *Journal of Pain*, 10(5), 447–485. <http://doi.org/10.1016/j.jpain.2008.12.001>
- Gagliese, L. (2009). Pain and Aging: The Emergence of a New Subfield of Pain Research. *Journal of Pain*, 10(4), 343–353. <http://doi.org/10.1016/j.jpain.2008.10.013>
- Geisser, M. E., Robinson, M. E., Keefe, F. J., & Weiner, M. L. (1994). Catastrophizing,

- depression and the sensory, affective and evaluative aspects of chronic pain. *Pain*, 59, 79-83. doi:10.1016/0304-3959(94)90050-7.
- George, S. Z., Dannecker, E. A., Robinson, M. E. (2006). Fear of pain, not pain catastrophizing, predicts acute pain intensity, but neither factor predicts tolerance or blood pressure reactivity: An experimental investigation in pain-free individuals. *European Journal of Pain*, 10, 457-465. doi: 10.1016/j.ejpain.2005.06.007.
- Grichnik, K. P., & Ferrante, F. M. (1991). The difference between acute and chronic pain. *The Mount Sinai Journal of Medicine*, 58(3), 217–220.
- Heck, R. H., & Thomas, S. L. (2015). *An introduction to multilevel modeling techniques: MLM and SEM approaches using Mplus*. Routledge: New York NY.
- Hirsh, A. T., George, S. Z., Bialosky, J. E., & Robinson, M. E. (2008). Fear of pain, pain catastrophizing, and acute pain perception: relative prediction and timing of assessment. *Journal of Pain*, 9, 806-812. doi: 10.1016/j.jpain.2008.03.012.
- Hursey, K. G., & Jacks, S. D. (1992). Fear of pain in recurrent headache sufferers. *Headache*, 32, 283-286. doi: 10.1111/j.1526-4610.1992.hed3206283.x.
- International Association for the Study of Pain. (1986). Classification of chronic pain. *Pain*, 3 (Suppl), S1-S226.
- Johnson, S. B., Blum, R. W., & Giedd, J. N. (2009). Adolescent maturity and the brain: The promise and pitfalls of neuroscience research in adolescent health policy. *Journal of Adolescent Health*, 45(3), 216-221.
- Jung, T., & Wickrama, K. A. (2008). An introduction to latent class growth analysis and growth mixture modeling. *Social and Personality Psychology Compass*, 2(1), 302–317.
<http://doi.org/10.1111/j.1751-9004.2007.00054.x>

- Keefe, F. J., Williams, D. A., & Smith, S. J. (2001). Assessment of pain behaviors. In D. C. Turk and R. Melzack (eds.), *Handbook of Pain Assessment*, 2nd edition, pp. 170-187. New York, NY: Guilford.
- Keith, T. Z. (2014). *Multiple regression and beyond: An introduction to multiple regression and structural equation modeling* (2nd Edition). Routledge: New York, NY.
- Kleinknecht, R. A., Klepac, R. K., & Alexander, L. D. (1973). Origins and characteristics of fear of dentistry. *Journal of American Dental Association*, *86*, 842-848.
- Koffman, J., Morgan, M., & Higginson, I. J. (2008). Cultural meanings of pain: A qualitative study of Black Caribbean and White British patients with advanced cancer. *Palliative Medicine*, *22*, 350-359.
- Kyle, B. N., McNeil, D. W., Weaver, B., & Wilson, T. (2016). Recall of dental pain and anxiety in a cohort of oral surgery patients. *Journal of Dental Research*, *95*(6), 629–634.
<http://doi.org/10.1177/00220345166631977>
- Lang, P. J. (1968). Fear reduction and fear behavior: Problems in treating a construct. *Research in Psychotherapy*, *1*, 90–102. <http://doi.org/10.1177/0192513X12437708>
- Larkin, K. T. (2005). *Stress & hypertension: Examining the relation between psychological stress and high blood pressure*. Yale University.
- Lethem, J., Slade, P. D., Troup, J. D. G., & Bentley, G. (1983). Outline of a fear-avoidance model of exaggerated pain perception-I. *Behaviour Research and Therapy*, *21*(4), 401–408. [http://doi.org/10.1016/0005-7967\(83\)90009-8](http://doi.org/10.1016/0005-7967(83)90009-8)
- Lautenbacher, S., Kunz, M., Strate, P., Nielsen, J., & Arendt-Nielsen, L. (2005). Age effects on pain thresholds, temporal summation and spatial summation of heat and pressure pain. *Pain*, *115*(3), 410–418. <http://doi.org/10.1016/j.pain.2005.03.025>

- Lee, K. C., Chiu, T. T. W., & Lam, T. H. (2007). The role of fear-avoidance beliefs in patients with neck pain: Relationships with current and future disability and work capacity. *Clinical Rehabilitation, 21*, 812–821. doi: 10.1177/0269215507077800.
- LeMay, K., Wilson, K. G., Buenger, U., Jarvis, V., Fitzgibbon, E., Bhimji, K., & Dobkin, P. (2011). Fear of pain in patients with advanced cancer or in patients with chronic noncancer pain. *Clinical Journal of Pain 27*, 116-124. doi: 10.1097/AJP.0b013e3181f3f667.
- Liebeskind, J. C., & Paul, L. A. (1977). Psychological and physiological mechanisms of pain. *Annual Review of Psychology, 28*(1), 41–60.
<http://doi.org/10.1146/annurev.ps.28.020177.000353>
- Lim, R. K. S. (1970). Pain. *Annual Review of Physiology, 32*, 269-288.
- Litman, L., Robinson, J., & Abberbock, T. (2017). TurkPrime.com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. *Behavior Research Methods, 49*(2), 433-442.
- Martin, R. R., Hadjistavropoulos, T., & McCreary, D. R. (2005). Fear of pain and fear of falling among younger and older adults with musculoskeletal pain conditions. *Pain Research and Management, 10*(4), 211–219.
- McCracken, L. M., Gross, R. T., Aikens, J., & Carnkike, Jr., C. L. M. (1996). The assessment of anxiety and fear in persons with chronic pain: A comparison of instruments. *Behaviour Research and Therapy, 34*, 927-933. doi:10.1016/S0005-7967(96)00057-5.
- McCracken, L. M., Gross, R. T., Sorg, P. J., & Edmands, T. A. (1993). Prediction of pain in

- patients with chronic low back pain: Effects of inaccurate prediction and pain-related anxiety. *Behaviour Research and Therapy*, *31*(7), 647–652. [https://doi.org/10.1016/0005-7967\(93\)90117-D](https://doi.org/10.1016/0005-7967(93)90117-D)
- McCracken, L. M., Zayfert, C., & Gross, R. T. (1992). The Pain Anxiety Symptoms Scale: Development and validation of a scale to measure fear of pain. *Pain*, *50*, 63-67. doi:10.1016/0304-3959(92)90113-P.
- McNeil, D. W., Arias, M. C., Randall, C. L. (2017). Anxiety versus fear. In A. E. Wenzel, D. Frideman-Wheeler, & E. Flannery-Schroeder (Eds.), *Encyclopedia of abnormal and clinical psychology* (pp. 279-280). Thousand Oaks, CA: Sage. <http://dx.doi.org/10.4135/9781483365817.n106>
- McNeil, D. W., Au, A. R., Zvolensky, M. J., McKee, D. R., Klineberg, I. J., & Ho, C. C. K. (2001). Fear of pain in orofacial pain patients. *Pain*, *89*, 245-252. doi:10.1016/S0304-3959(00)00368-7.
- McNeil, D. W., Helfer, A. J., Weaver, B. D., Graves, R. W., Kyle, B. N., & Davis, A. M. (2011). Memory of pain and anxiety associated with tooth extraction. *Journal of Dental Research*, *90*(2), 220–224. <http://doi.org/10.1177/0022034510385689>
- McNeil, D. W., & Rainwater III, A. J. (1998). Development of the Fear of Pain Questionnaire-III. *J Behav Med* *21*, 169-190. doi: 10.1023/A:1018782831217.
- McNeil, D. W., & Randall, C. L. (2014). Dental fear and anxiety associated with oral health care: Conceptual and clinical issues. In D. I. Mostofsky and F. Fortune (eds.). *Behavioral dentistry*, 2nd edition, Ames, IA: John Wiley & Sons, Inc.
- McNeil, D. W., Vargovich, A. M., Sorrell, J. T., & Vowles, K. E. (2014). Environmental,

- emotional, and cognitive determinants of dental pain. In D. I. Mostofsky and F. Fortune (eds.). *Behavioral dentistry*, 2nd edition, Ames, IA: John Wiley & Sons, Inc.
- McNeil, D. W., Vargovich, A. M., Turk, C. L., & Ries, B. J. (2012). Anxiety and fear. In *Encyclopedia of human behavior*, Vol. 1, 2nd edition. V. Ramachandran, ed. (San Diego, CA: Academic Press) pp. 161-168.
- McNeil, D. W., & Vowles, K. E. (2004). Assessment of fear and anxiety associated with pain: Conceptualization, methods, and measures. In *Understanding and treating fear of pain*. G. Asmundson, J. Vlaeyen, & G. Crombez, eds. (Oxford: Oxford University Press) pp. 189-211.
- McNeil, D. W., Kennedy, S. G., Randall, C. L., Addicks, S. H., Wright, C. D., Hursey, K. G., & Vaglienti, R. (2018). Brief assessment of fear of pain with the Fear of Pain Questionnaire-9. *European Journal of Pain*, 22(1), 39-48. doi: 10.1002/ejp.1074.
- Merskey, H. & Bogduk, N. (1994). Part III: Pain terms, a current list with definitions and notes on usage, In *Classification of chronic pain*, 2nd Edition, IASP Task Force on Taxonomy, IASP Press, Seattle, 209-214.
- Molton, I. R., & Terrill, A. L. (2014). Overview of persistent pain in older adults. *American Psychologist*, 69(2), 197–207. <http://doi.org/10.1037/a0035794>
- Muthén, L. K., & Muthén, B. O. (1998-2015). *Mplus User's Guide*, Muthén & Muthén, Los Angeles, Calif, USA, 7th edition.
- National Center for Health Statistics. (2016). *Health, United States, 2016: With chartbook on long-term trends in health*. Hyattsville, MD. Retrieved from <https://www.cdc.gov/nchs/data/abus/abus16.pdf#076>
- National Institutes of Health. (2017). "Pain Management". Retrieved from

<https://report.nih.gov/nihfactsheets/ViewFactSheet.aspx?csid=57>

- Osman, A., Breitenstein, J. L., Barrios, F. X., Gutierrez, P.M., & Kopper, B.A. (2002). The Fear of Pain Questionnaire-III: Further reliability and validity with nonclinical samples. *Journal of Behavioral Medicine, 25* (2), 155-173. doi: 10.1023/A:1014884704974.
- Parmelee, P. Measuring mood and psychosocial function associated with pain in late life, in Gibson SJ, Weiner DK (Eds): *Progress in Pain Research and Management: Pain in the Older Person*. Seattle, IASP Press, 2005, pp 175-202
- Parr, J. J., Borsa, P. A., Fillingim, R. B., Tillman, M. D., Tillman, M. D., Gregory, C. M., & George, S. Z. (2012). Pain-related fear and catastrophizing predict pain intensity and disability independently using an induced muscle injury model. *Journal of Pain, 13*, 370-
- Polk, D. E., Weyant, R. J., Crout, R. J., McNeil, D. W., Tarter, R. E., Thomas, J. G., & Marazita, M. L. (2008). Study protocol of the Center for Oral Health Research in Appalachia (COHRA) etiology study. *BMC Oral Health, 8*, 18. <https://doi.org/10.1186/1472-6831-8-18>
- Quartana, P. J., Campbell, C. M., & Edwards, R. R. (2009). Pain catastrophizing: A critical review. *Expert Review of Neurotherapeutics, 9*(5), 745–758. <http://doi.org/10.1586/ERN.09.34.Pain378>. doi:10.1016/j.jpain.2011.12.011.
- Racine, M., Tousignant-Laflamme, Y., Kloda, L. A., Dion, D., Dupuis, G., & Choinire, M. (2012a). A systematic literature review of 10 years of research on sex/gender and experimental pain perception - Part 1: Are there really differences between women and men? *Pain, 153*(3), 602–618. <http://doi.org/10.1016/j.pain.2011.11.025>
- Racine, M., Tousignant-Laflamme, Y., Kloda, L. A., Dion, D., Dupuis, G., & Choinire, M.

- (2012b). A systematic literature review of 10 years of research on sex/gender and pain perception - Part 2: Do biopsychosocial factors alter pain sensitivity differently in women and men? *Pain*, *153*(3), 619–635. <http://doi.org/10.1016/j.pain.2011.11.026>
- Randall, C. L., Wright, C. D., Chernus, J., McNeil, D. W., Feingold, E., Neiswanger, K., Crout, R. J., Weyant, R. J., Shaffer, J. R., & Marazita, M. L. (2017). A genome-wide association study of fear of pain: Implications for orofacial pain. *Pain Research and Management*, *2017*, 7375468.
- Randall, C. L., McNeil, D. W., Shaffer, J. R., Crout, R. J., Weyant, R. J., & Marazita, M. L. (2016a). Fear of Pain Mediates the Association between *MC1R* Genotype and Dental Fear. *Journal of Dental Research*, *95*(10), 1132–1137. <http://doi.org/10.1177/0022034516661151>
- Randall, C. L., Shaffer, J. R., McNeil, D. W., Crout, R. J., Weyant, R. J., & Marazita, M. L. (2016). Toward a genetic understanding of dental fear: Evidence of heritability. *Community Dentistry and Oral Epidemiology*, 1–8. <http://doi.org/10.1111/cdoe.12261>
- Randall, C. L., Shulman, G. P., & McNeil, D. W. (2014). Gagging during dental treatment: Associations with dental care-related fear, fear of pain, and beliefs about treatment. *Journal of the American Dental Association*, *145*, 452-458.
- Riley, J. L., Wade, J. B., Myers, C. D., Sheffield, D., Papas, R. K., & Price, D. D. (2002). Racial/ethnic differences in the experience of chronic pain. *Pain*, *100*(3), 291–298. [http://doi.org/10.1016/S0304-3959\(02\)00306-8](http://doi.org/10.1016/S0304-3959(02)00306-8)
- Roelofs, J., Peters, M. L., Deutz, J., Spijker, C., & Vlaeen, J. W. S. (2005). The Fear of Pain Questionnaire (FPQ): Further psychometric examination in a non-clinical sample. *Pain*, *116*, 339-346. doi:10.1016/j.pain.2005.05.003.

- Romano, J. M., & Turner, J. A. (1985). Chronic pain and depression: Does the evidence support a relationship? *Psychological Bulletin*, *97*, 18-34. doi: 10.1037/0033-2909.97.1.18.
- Selye, H. (1956). *The Stress of Life*. New York, NY: McGraw-Hill.
- Schneiderman, N., Ironson, G., & Siegel, S. D. (2005). Stress and health: Psychological, behavioral, and biological determinants. *Annual Review of Clinical Psychology*, *1*, 607–628. <http://doi.org/10.1146/annurev.clinpsy.1.102803.144141.STRESS>
- Sieben, J. M., Vlaeyen, J. W. S., Portegijs, P. J. M., Verbunt, J. A., Van Riet-Rutgers, S., Kester, A. D. M., ... André Knottnerus, J. (2005). A longitudinal study on the predictive validity of the fear-avoidance model in low back pain. *Pain*, *117*(1–2), 162–170. <http://doi.org/10.1016/j.pain.2005.06.002>
- Shega, J. W., Tiedt, A. D., Grant, K., & Dale, W. (2014). Pain measurement in the national social life, health, and aging project: Presence, intensity, and location. *Journals of Gerontology - Series B Psychological Sciences and Social Sciences*, *69*, S191–S197. <http://doi.org/10.1093/geronb/gbu101>
- Sperry-Clark, J. A., McNeil, D. W., & Ciano-Federoff, L. (1999). Assessing chronic pain patients: The Fear of Pain Questionnaire-III. In *Innovations in clinical practice: A source book*. L. VandeCreek & T. Jackson, eds. (Sarasota, FL: Professional Resource Press) pp. 293-305.
- Treede, R., Rief, W., Barke, A., Aziz, Q., Bennett, M. I., Benoliel, R., Cohen, M... Wang, S. (2015). A classification of chronic pain for *ICD-11*. *Pain*, *156*(6), 1003-1007.
- Turk, D. C., Robinson, J. P., & Burwinkle, T. (2004). Prevalence of fear of pain and activity in patients with fibromyalgia syndrome. *Journal of Pain*, *5*, 483-490. doi:10.1016/j.jpain.2004.08.002.

- van den Hout, J. H. C., Vlaeyen, J. W. S., Houben, R. M. A., Soeters, A. P. M., & Peters, M. L. (2001). The effects of failure feedback and pain-related fear on pain report, pain tolerance, and pain avoidance in chronic low back pain patients. *Pain, 92*(1–2), 247–257. [http://doi.org/10.1016/S0304-3959\(01\)00261-5](http://doi.org/10.1016/S0304-3959(01)00261-5)
- van Wijk, A. J., & Hoogstraten, J. (2006). Dutch translation of the Fear of Pain Questionnaire: Factor structure, reliability, and validity. *European Journal of Pain, 10*, 479–486. doi:10.1016/j.ejpain.2005.06.008.
- van Wijk, A. J., & Hoogstraten, J. (2009). Anxiety and pain during dental injections. *Journal of Dentistry, 37*(9), 700–704. doi:10.1016/j.jdent.2009.05.023.
- Vlaeyen, J. W., de Johng, J., Geilen, M., Heuts, P. H. T. G., & van Breuklen, G. (2001). Graded exposure in vivo in the treatment of pain-related fear: A replicated single-case experimental design in four patients with chronic low back pain. *Behaviour Research and Therapy, 39*(2), 151–166. doi:10.1016/S0005-7967(99)00174-6.
- Vlaeyen, J., & Linton, S. (2000). Fear-avoidance and its consequences in chronic musculoskeletal pain: A state of the art. *Pain, 85*, 317–332.
- Waddell, G., Newton, M., Henderson, I., Somerville, D. & Main, C. (1993). A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. *Pain, 52*, 157–168.
- Wang, J., & Wang, X. (2012). Structural equation modeling: Applications using Mplus, Higher Education Press, West Sussex, UK.
- Ward, L. C., & Thorn, B. E. (2006). The fear-avoidance model of chronic pain: Further thoughts on the process of validating a causal model. *Pain, 121*(3), 173–174. <http://doi.org/10.1016/j.pain.2006.01.002>

- Wiesenfeld-Hallin, Z. (2005). Sex differences in pain perception. *Gender Medicine*, 2(3), 137–145. [http://doi.org/10.1016/S1550-8579\(05\)80042-7](http://doi.org/10.1016/S1550-8579(05)80042-7)
- Williams, J., Hadjistavropoulos, T., & Asmundson, G. (2005). The effects of age and fear of pain on attentional and memory biases relating to pain and falls. *Anxiety, Stress and Coping*, 18, 53–69. <http://doi.org/10.1080/10615800420004184>
- Wittink, H. M. H. M., Rogers, W. H., Lipman, A. G., Mccarberg, B. H., Ashburn, M. A., Oderda, G. M., & Carr, D. B. (2006). Older and Younger Adults in Pain Management Programs in the United States: Differences and Similarities. *Pain Medicine (Malden, Mass.)*, 7(2), 151–163.
- Wright, C. D., McNeil, D. W., Edwards, C. B., Crout, R. J., Neiswanger, K., Shaffer, J. R. & Marazita, M. L. (2017). Periodontal status and quality of life: Impact of fear of pain and dental fear. *Pain Research and Management*.
- Zarit, S. H., Griffiths, P. C., & Berg, S. (2004). Pain perceptions of the oldest old: a longitudinal study. *The Gerontologist*, 44(4), 459–68. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/15331803>
- Zvolensky, M. J., Goodie, J. L., McNeil, D. W., Sperry, J. S., & Sorrell, J. T. (2001). Anxiety sensitivity in the prediction of pain-related fear and anxiety in a heterogeneous chronic pain population. *Behaviour Research and Therapy*, 39, 683-696. doi:10.1016/S0005-7967(00)00049-8.
- Zyczkowska, J., Szczerbińska, K., Jantzi, M. R., & Hirdes, J. P. (2007). Pain among the oldest old in community and institutional settings. *Pain*, 129(1–2), 167–176. <http://doi.org/10.1016/j.pain.2006.12.0>

Tables

Table 1

Correlation table of missingness

		Sex Miss	Sev Miss	Minor Miss	MedDent Miss	Total Miss	Age (Years)	Sex (Male)	Severe	Minor	Medical Dental	Total
Sex_Missing	<i>r</i>	1										
	N	4288										
Sev_Missing	<i>r</i>	-0.012	1									
	N	4288	4288									
Minor_Missing	<i>r</i>	-0.012	.858**	1								
	N	4288	4288	4288								
MedDent_Missing	<i>r</i>	0.008	.882**	.866**	1							
	N	4288	4288	4288	4288							
Total_Missing	<i>r</i>	0.005	.897**	.897**	.894**	1						
	N	4288	4288	4288	4288	4288						
Age (Years)	<i>r</i>	0.025	-0.022	-0.025	-0.020	-0.011	1					
	N	4288	4288	4288	4288	4288	4288					
Sex (Male)	<i>r</i>	. ^a	-0.004	-0.008	-0.004	-0.008	0.017	1				
	N	4275	4275	4275	4275	4275	4275	4275				
Severe	<i>r</i>	-0.019	. ^a	-.047**	-0.013	-.041**	.123**	-.167**	1			
	N	4088	4088	4088	4088	4088	4088	4075	4088			
Minor	<i>r</i>	-0.013	0.012	. ^a	0.006	0.009	.092**	-.075**	.528**	1		
	N	4088	4088	4088	4088	4088	4088	4075	4061	4088		
Medical Dental	<i>r</i>	-0.004	0.008	0.014	. ^a	0.014	-.073**	-.182**	.529**	.548**	1	
	N	4089	4089	4089	4089	4089	4089	4077	4066	4063	4089	
Total	<i>r</i>	-0.011	. ^a	. ^a	. ^a	. ^a	.059**	-.175**	.851**	.803**	.834**	1
	N	4042	4042	4042	4042	4042	4042	4030	4042	4042	4042	4042

** . Correlation is significant at the 0.01 level (2-tailed).

a. Cannot be computed because at least one of the variables is constant.

Table 2

Missing data counts for variables used in regressions.

	<i>N</i>	%
Age	0	0%
Sex	13	0.3%
Fear of Severe Pain	200	4.7%
Fear of Minor Pain	200	4.7%
Fear of Medical/Dental Pain	199	4.6%
FPQ-9 Total Score	246	5.7%

Table 3

Descriptive information for various archival datasets included in study.

Dataset	<i>n</i>	Sex (<i>n</i> / %)		Age Range (<i>M</i> / <i>SD</i>)	Race/Ethnicity	
COHRA1	1,339	Females	852 (63.6%)	18-92 (34.3/9.5)	Caucasian	1,184 (88.4%)
		Males	487 (36.4%)		African American	103 (7.7%)
					Asian American	4 (0.3%)
					Hispanic/Latino	10 (0.7%)
					Native American	4 (0.3%)
					Other/Multiracial	5 (0.4%)
Oral Health Values 1	301	Females	175 (58.1%)	21-70 (39.7/11.9)	Caucasian	226 (75.1%)
		Males	125 (41.1%)*		African American	36 (12.0%)
					Asian American	24 (8.0%)
					Hispanic/Latino	N/A
					Native American	N/A
					Other/Multiracial	15 (5.0%)
Oral Health Values 2	307	Females	163 (53.1%)	18-98 (36.0/12.1)	Caucasian	256 (83.4%)
		Males	142 (46.3%)**		African American	24 (7.8%)
					Asian American	16 (5.2%)
					Hispanic/Latino	N/A
					Native American	2 (0.7%)
					Other/Multiracial	9 (3.0%)
FPQ-9 Development	826	Females	486 (58.8%)	18-85 (31.9/15.8)	Caucasian	268 (93.1%) [§]
		Males	333 (40.3%)***		African American	11 (3.8%)
					Asian American	3 (1.0%)
					Hispanic/Latino	N/A
					Native American	2 (0.7%)
					Other	1 (0.3%)
Oral diagnosis	687	Females	364 (53.0%)	18-90 (37.4/15.0)	Caucasian	633 (92.1%)
		Males	320 (46.6%)****		African American	31 (4.5%)
					Asian American	6 (0.9%)
					Hispanic/Latino	4 (0.6%)
					Native American	4 (0.6%)
					Other	6 (0.9%)
New Valid MTurk	828	Females	488 (58.9%)/	18-82 (48.0/12.7)	Caucasian	671 (81.0%)
		Males	340 (41.1%)		African American	75 (9.1%)
					Asian American	46 (5.6%)
					Hispanic/Latino	38 (4.6%)
					Native American	16 (1.9%)
					Other	8 (1.0%)
Total	4,288	Females	2,528 (59.1%)	18-98 (37.5/14.0)	Caucasian	3,238 (75.5%)
		Males	1,747 (40.9%) _§		African American	280 (6.5%)
					Asian American	99 (2.3%)
					Hispanic/Latino	52 (1.2%)
					Native American	28 (0.7%)
					Other	44 (1.0%)

Note: *1 missing **2 missing ***7 unknown; ****3 missing; FPQ-9 Development dataset includes 455 undergraduates and 371 pain patients. § Of the 687 FPQ-9 Development participants, only 285 had race/ethnicity data, thus percentage is a function of only those with data. ζ 13 missing on sex variable.

Table 4

MPlus standardized results from structural equation modeling regressions of age and sex predicting FPQ-9 scores. Due to variance being too large to estimate in MPlus, linearity of relations were assumed. See also Figure 2.

Fear of Severe Pain	β	Std. Error	Est./S.E.	<i>p</i> -value
Sex (Male)	-0.181	0.017	-10.919	< 0.001
Age (Years)	0.135	0.017	8.152	< 0.001
Fear of Minor Pain	β	Std. Error	Est./S.E.	<i>p</i> -value
Sex (Male)	-0.092	0.018	-5.137	< 0.001
Age (Years)	0.107	0.017	6.113	< 0.001
Fear of Medical/ Dental Pain	β	Std. Error	Est./S.E.	<i>p</i> -value
Sex (Male)	-0.215	0.017	-12.352	< 0.001
Age (Years)	-0.083	0.018	-4.713	< 0.001
Fear of Pain Total	β	Std. Error	Est./S.E.	<i>p</i> -value
Sex (Male)	-0.193	0.018	-10.798	<.001
Age (Years)	0.069	0.019	3.710	<.001

Table 5

Ordinary least squares regression models of age and sex predicting FPQ-9 scores to show quadratic and cubic terms.

Fear of Severe Pain	β	Std. Error	t	p -value
Sex (Male)	-0.168	0.105	-11.029	<0.001
Age (Years)	-0.722	0.067	-2.625	0.009
Age (Quadratic)	2.076	0.002	3.761	<0.001
Age (Cubic)	-1.278	0.000	-4.363	<0.001
Fear of Minor Pain	β	Std. Error	t	p -value
Sex (Male)	-0.076	0.079	-4.867	<0.001
Age (Years)	-0.206	0.050	-0.736	0.462 [§]
Age (Quadratic)	0.739	0.001	1.312	0.190
Age (Cubic)	-0.457	0.000	-1.527	0.127
Fear of Medical Dental Pain	β	Std. Error	t	p -value
Sex (Male)	-0.181	0.094	-11.797	<0.001
Age (Years)	-0.929	0.060	-3.353	0.001
Age (Quadratic)	1.798	0.001	3.233	0.001
Age (Cubic)	-0.974	0.000	-3.298	0.001
Fear of Pain Total	β	Std. Error	t	p -value
Sex (Male)	-0.176	0.233	-11.366	<.001
Age (Years)	-0.765	0.147	-2.749	0.006
Age (Quadratic)	1.904	0.003	3.411	0.001
Age (Cubic)	-1.120	0.000	-3.783	<0.001

§ Since quadratic and cubic terms are non-significant, when taken out of the model, and just age and sex are included, age is significantly associated in a linear fashion ($\beta = 0.094$, $p < .001$).

Table 6

Fit statistics for unconditional latent class analysis. Each model was tested with k classes and fit was compared to model with k-1 classes where k is the number of classes. Models included 4,117 participants due to missing data.

	AIC	BIC	ABIC	Entropy	LMRLR	ALMRLR	BLRT
1 class	61342.401	61380.338	61361.273	-	-	-	-
2 class	58824.395	58887.624	58855.848	0.711	< 0.0001	< 0.0001	< 0.0001
3 class	57579.634	57668.154	57623.668	0.768	< 0.0001	< 0.0001	< 0.0001
4 class	57246.265	57360.076	57302.880	0.722	0.0004	0.0005	< 0.0001
5 class	57074.408	57213.512	57143.605	0.760	0.0069	0.0077	< 0.0001

Note: MPlus did have a warning of lrt draws, increase starts, and issues with local maxima, but the model terminated normally.

Table 7

Fit statistics for conditional latent class analysis. Each model was tested with k classes and fit was compared to model with k-1 classes where k is the number of classes. Models included 4,117 participants due to missing data.

	AIC	BIC	ABIC	Entropy	LMRLR	ALMRLR	BLRT
1 class	102185.74	102249.38	102217.60	-	-	-	-
2 class	58506.21	58582.05	58543.92	0.72	< 0.001	< 0.001	< 0.0001
3 class	57288.48	57402.24	57345.04	0.77	< 0.001	< 0.001	< 0.0001
4 class	56956.98	57108.65	57032.39	0.72	0.022	0.023	< 0.0001
5 class	56684.79	56874.38	56779.06	0.77	0.0004	0.0004	< 0.0001

Note: MPlus did have a warning of lrt draws, increase starts, and issues with local maxima, but the model terminated normally.

Figures

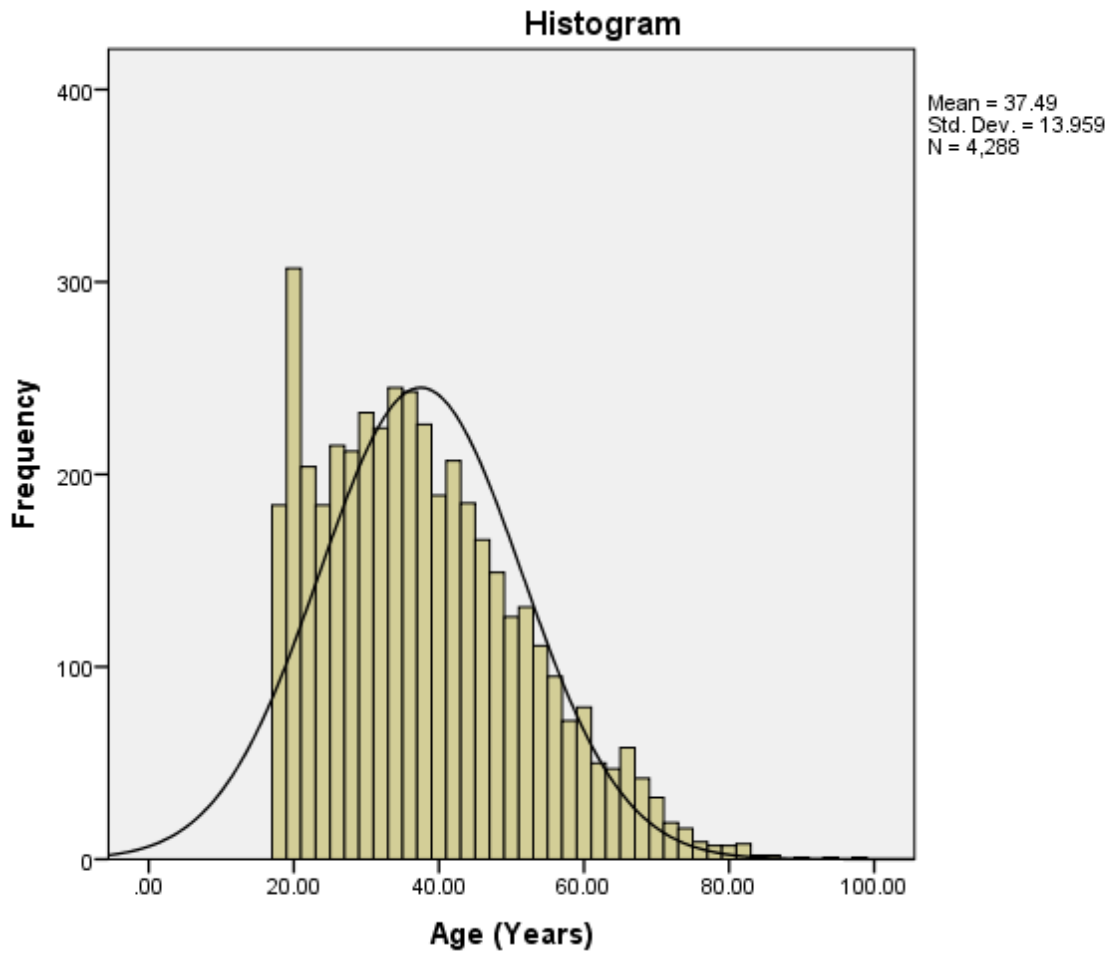


Figure 1. Histogram of age data for entire combined sample (N = 4,288).

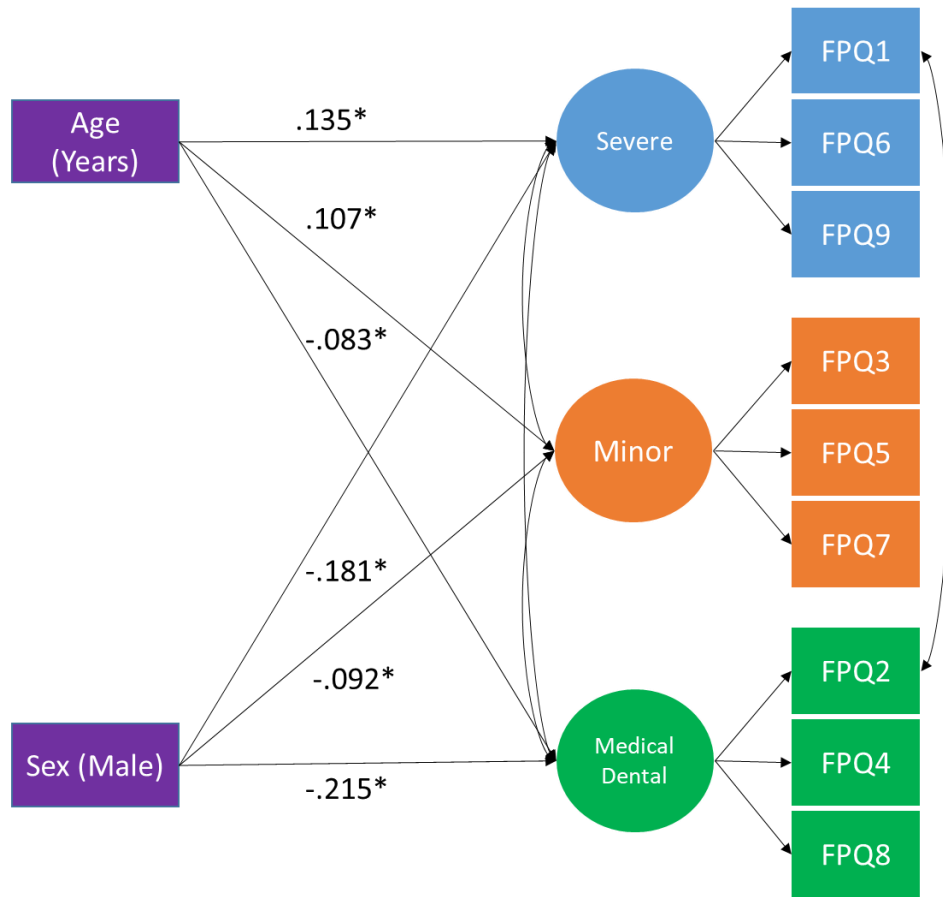


Figure 2. Standardized results and standard errors of a structural equation model (SEM) to show the relation between age and FPQ-9 subscale scores. After utilizing modification indices, FPQ1 and FPQ2 were allowed to correlate resulting in improved model fit (RMSEA = .07; CFI = .95; TLI = .92; SRMR = .03). * denotes $p < .001$.

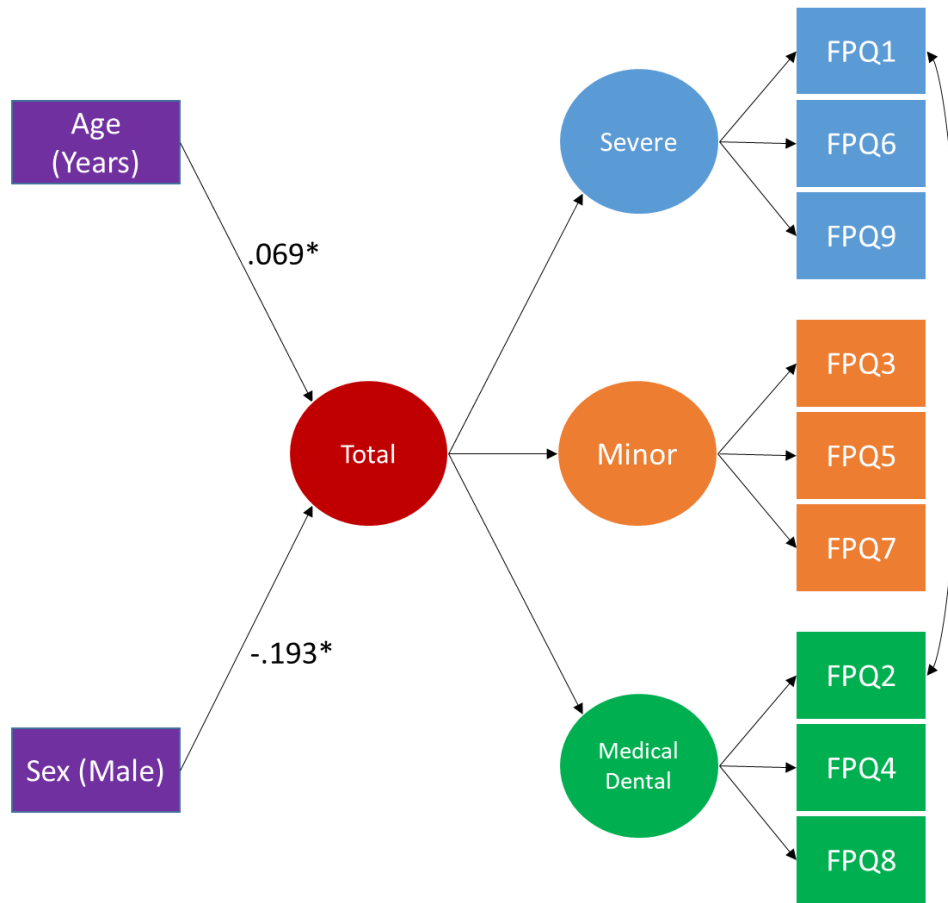


Figure 3. Standardized results of a structural equation model (SEM) to show the relation between age and FPQ-9 total score. After utilizing modification indices, FPQ1 and FPQ2 were allowed to correlate resulting in improved model fit (RMSEA = .07; CFI = .93; TLI = .90; SRMR = .04).

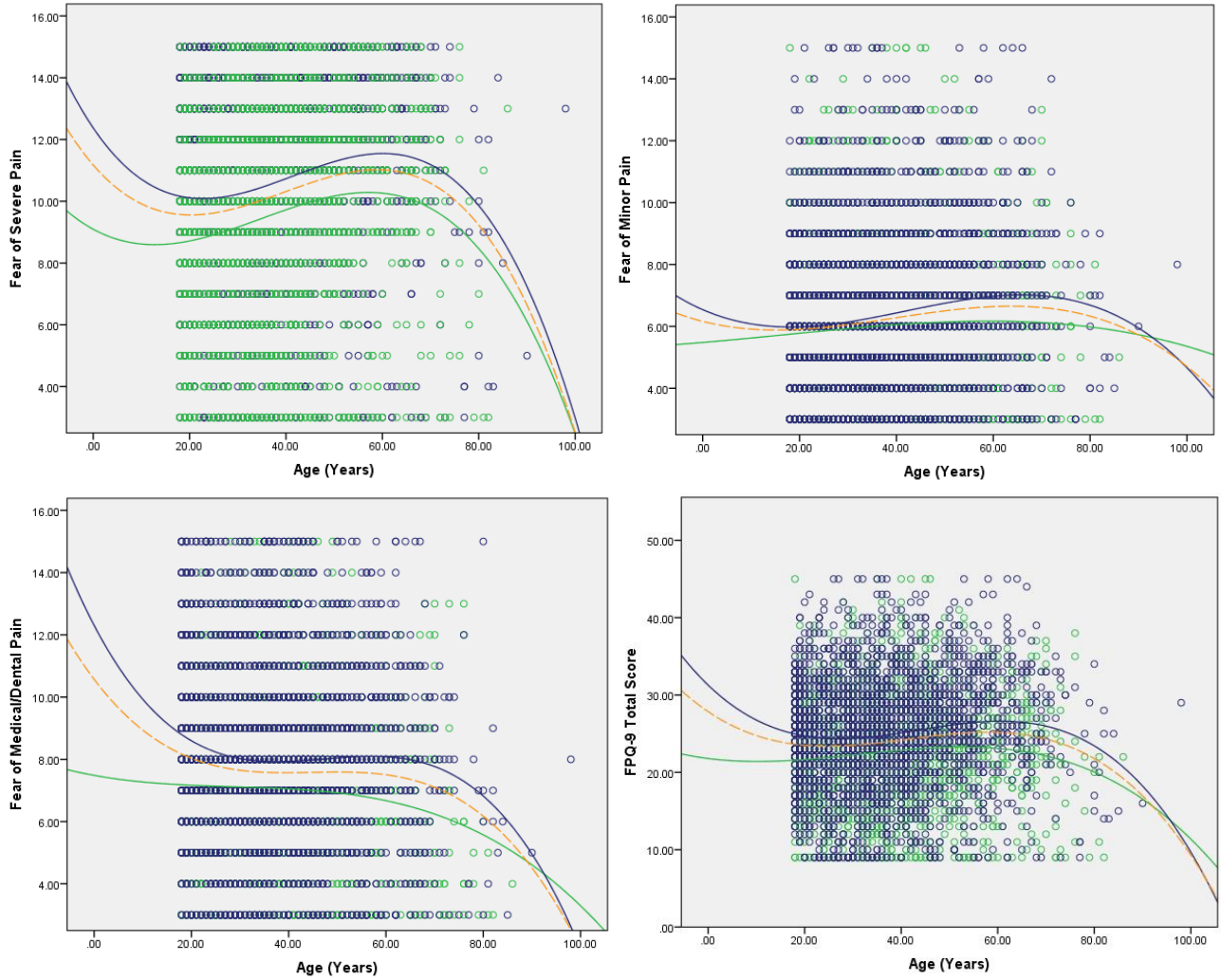


Figure 4. Scatterplots for each of the three FPQ-9 subscales and the total score to show cubic function results. In each scatterplot, the blue line indicates females, green indicates males, and the orange dashed line indicates the overall best-fitting line.

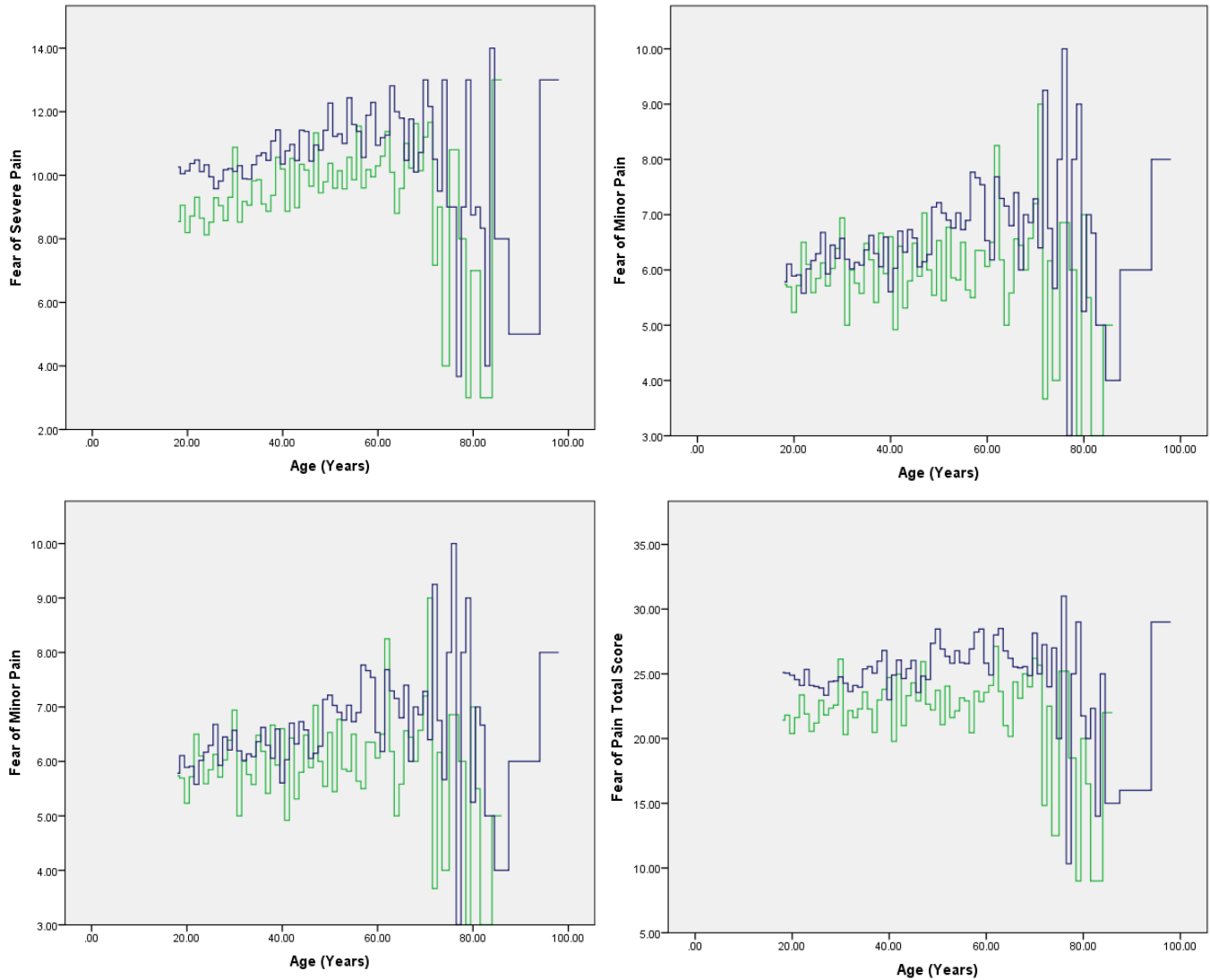


Figure 5. Interpolations for each of the three FPQ-9 subscales and the total score to show cubic function results. In each scatterplot, the blue line indicates females, green indicates males.

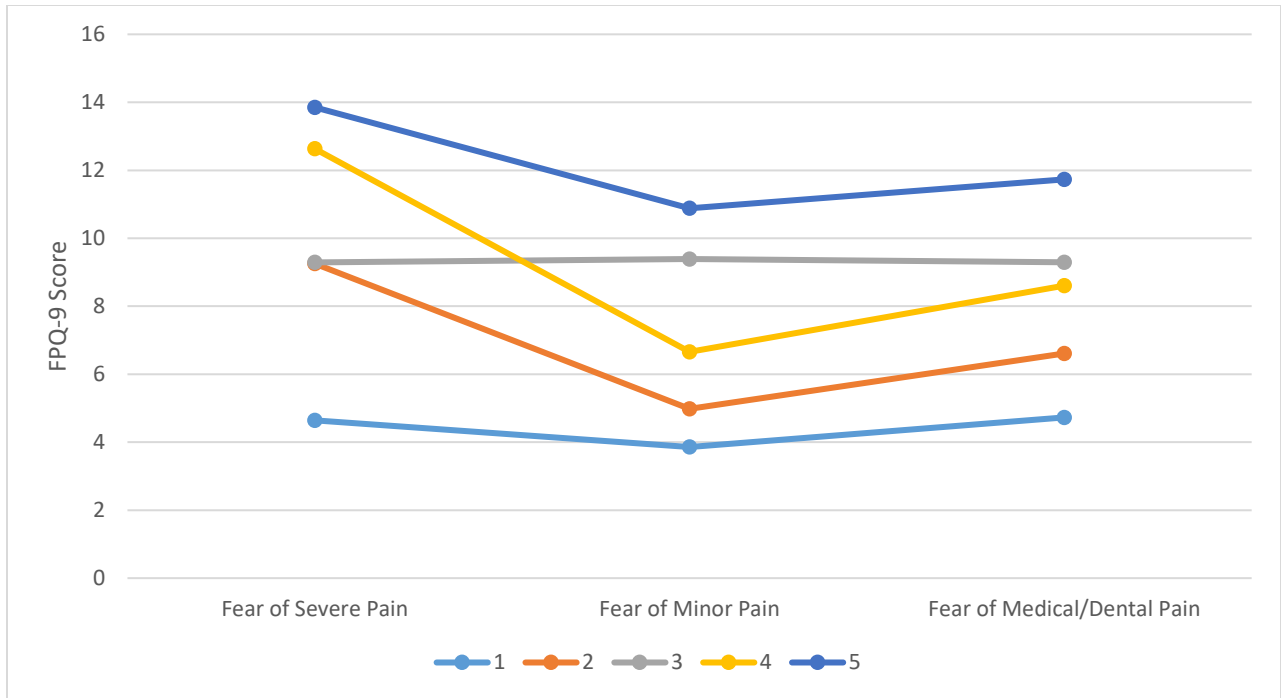


Figure 6. Latent class analysis results for the FPQ-9 Subscales. Five classes were extracted.

Appendix A

FEAR OF PAIN QUESTIONNAIRE-9 (FPQ-9)

Name: _____ Date: _____

INSTRUCTIONS: The items listed below describe painful experiences. Please look at each item and think about how **FEARFUL** you are of experiencing the **PAIN** associated with each item. If you have never experienced the **PAIN** of a particular item, please answer on the basis of how **FEARFUL** you expect you would be if you had such an experience. Circle one number for each item below to rate your **FEAR OF PAIN** in relation to each event.

I FEAR the PAIN associated with:

	Not At All	A Little	A Fair Amount	Very Much	Extreme
1. Breaking your arm.	1	2	3	4	5
2. Having a foot doctor remove a wart from your foot with a sharp instrument.	1	2	3	4	5
3. Getting a paper-cut on your finger.	1	2	3	4	5
4. Receiving an injection in your mouth.	1	2	3	4	5
5. Getting strong soap in both your eyes while bathing or showering.	1	2	3	4	5
6. Having someone slam a heavy car door on your hand.	1	2	3	4	5
7. Gulping a hot drink before it has cooled.	1	2	3	4	5
8. Receiving an injection in your hip/buttocks.	1	2	3	4	5
9. Falling down a flight of concrete stairs.	1	2	3	4	5

Note. The FPQ-9 is copyrighted by the authors. Permission is given for users to reproduce the instrument for clinical and research purposes.

Appendix B

Scoring Instructions
Fear of Pain Questionnaire-9

1. Score the Fear of Severe Pain subscale by summing values for the following items: 1, 6, 9
2. Score the Fear of Minor Pain subscale by summing values for the following items: 3, 5, 7
3. Score the Fear of Medical/Dental Pain subscale by summing values for the following items: 2, 4, 8
4. Calculate the Total Score by summing the three subscale values, or simply sum all 9 items. (You may wish to calculate the Total Score both ways, to check for possible errors.)

Note. Each subscale contains 3 items, so the possible range of scores for each subscale is 3 through 15. The Total score has a range of 9 through 45.

The 9 items of the Short Form-FPQ items correspond exactly to those in the 30 item Fear of Pain Questionnaire as follows:

FPQ-9 Item #	FPQ-III Item #
1	3
2	21
3	19
4	17
5	24
6	9
7	23
8	14
9	10

Appendix C

Validation Items

What is your age in years?

What is your age in years? (asked a second time later in the demographic portion of survey)

What year were you born? (to be + or – 1 from age in years)

Please select the number four for this question

1 2 3 4 5

What color are healthy teeth?

Red

Green

White

Black

What color are healthy gums?

Blue

Pink

Green

Silver

How many eyes are most people born with?

0 1 2 3 4